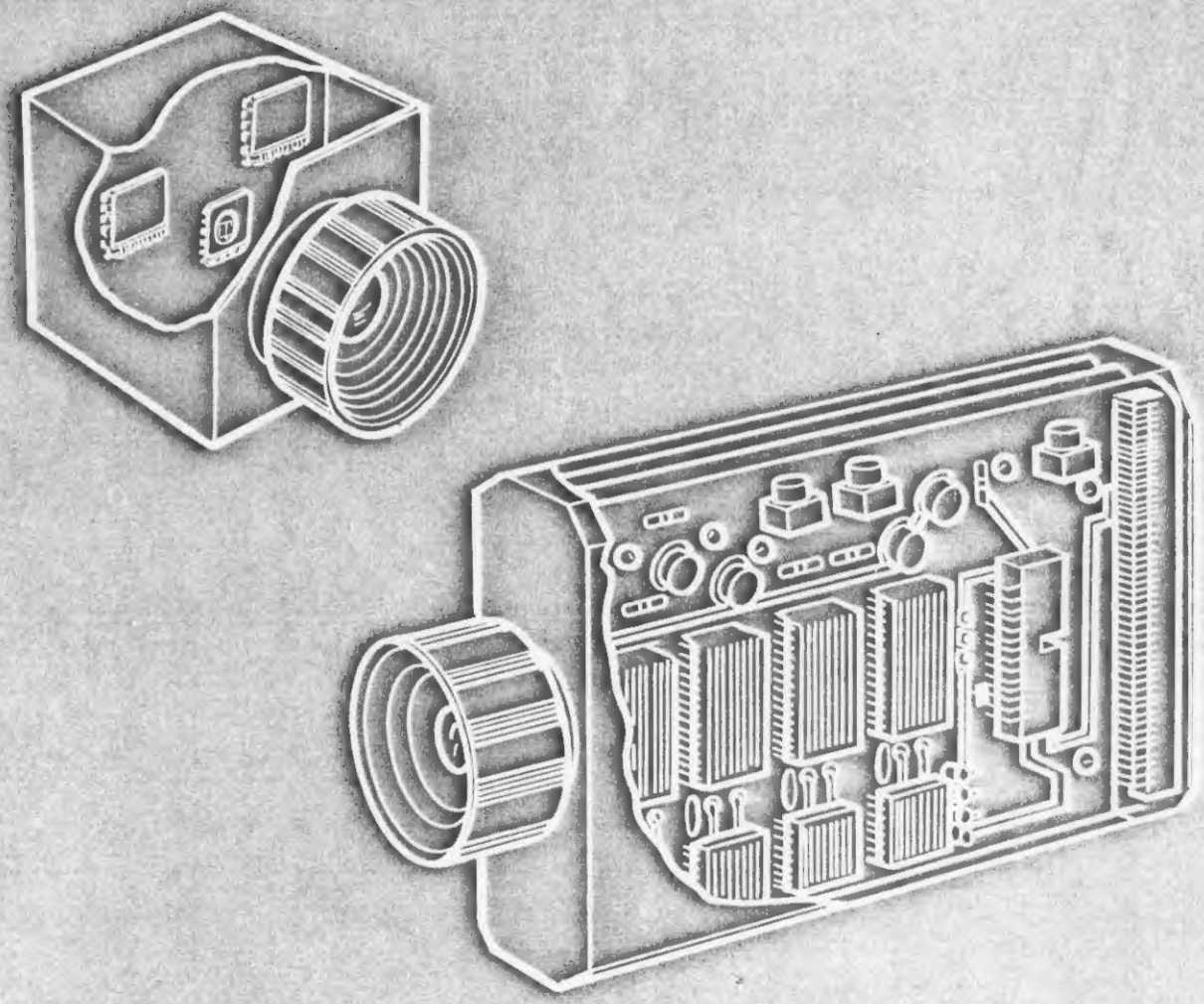
DTE 128A

THOMSON-CSF
TUBES ELECTRONIQUES

Application Modules and Integrated circuits for C C D image sensors



Modules et circuits intégrés de mise en œuvre pour capteurs photosensibles D T C

CARTES DE MISE EN OEUVRE ET CIRCUITS INTÉGRÉS POUR DTC PHOTOSENSIBLES

THOMSON-CSF produit une gamme de cartes électroniques et circuits intégrés (CI) destinés à la réalisation de caméras complètes à partir de DTC photosensibles matriciels ou linéaires. Ces cartes et CI sont conçus pour la génération des horloges de commande ainsi que pour la gestion et le traitement des signaux vidéo et permettent éventuellement des mises en œuvre spécifiques. Il sont utilisables aussi bien pour la fabrication de caméras qu'en modules d'évaluation.

DRIVE BOARD MODULES AND INTEGRATED CIRCUITS FOR CCD IMAGE SENSORS

Our range of drive boards and integrated circuits (ICs) allows complete cameras to be constructed from Thomson-CSF linear and area array CCD image sensors. These boards and ICs provide the drive clock, video signal management, processing functions and are adaptable to specific applications. They can be used both as evaluation modules and for the production of cameras.

CARTES D'INTERFACE POUR DTC LINEAIRES
DRIVE BOARDS FOR LINEAR-ARRAY CCDs

Fonctions

- Génération de phases
- Support de capteur
- Interface TTL/MOS
- Sortie vidéo analogique

Functions

- *Clock generation*
- *Sensor mount*
- *TTL/MOS interface*
- *Analog video output*

TH 79
TH 7931C x 1024 e 256

Tableau de correspondance des cartes de mise en œuvre/ Capteur DTC linéaire
Drive board/Linear CCD sensor correspondence table

Capteur *Sensor*		Carte de mise en œuvre *Drive board*		
Référence capteur *Sensor reference*	Fréquence de sortie *Output frequency*	Référence carte *Board reference*	Dimensions *Dimensions*	Alimentations utilisées *Power supply req.*
TH 7801ACDZ 1728 TH 7802ACDZ 1024 TH 7803ACDZ 1728	2 MHz	TH 7931B	115 mm x 65 mm	+ 15 V + 5 V
TH 7811CDZ ?		TH 7931B1		
TH 7806CD 256 TH 7806CDZ TH 7831CDZ 1728	2 MHz	X TH 7931C 27 cc ~ 600.000		
TH 7804CDZ 1024	15 MHz	TH X1061	100 mm x 160 mm	+ 20 V + 5 V
TH 7805ACDZ 2048	20 MHz min. 5 mHz	X TH 7932 (ex TH X1074)	1.200.000 100 mm x 160 mm	+ 18 V + 5 V
THX 31510CDZ ?	40 MHz	T.B.D.*	-	
TH 7832CDZ ?	-	T.B.D.*	-	

* En cours de définition/ *To be defined*

CIRCUITS INTEGRES POUR DTC MATRICIELS A TRANSFERT DE TRAME

Ces circuits intégrés, de conception VLSI avancée, ont été réalisés spécialement pour gérer les matrices DTC à transfert de trame THOMSON-CSF.

Caractérisés par leurs simplicité de mise en œuvre, faible consommation et haut degré de miniaturisation, ils constituent des éléments de base pour la réalisation de systèmes de prise de vue à l'état solide sophistiqués. Les modèles présentés permettent de réaliser toutes les fonctions essentielles afférantes à ces capteurs, depuis leur séquencement jusqu'à la mise en forme du signal de sortie.

Ils peuvent ête proposés en classes de qualité militaire ou industrielle.

INTEGRATED CIRCUITS FOR FRAME TRANSFER CCD IMAGE SENSORS

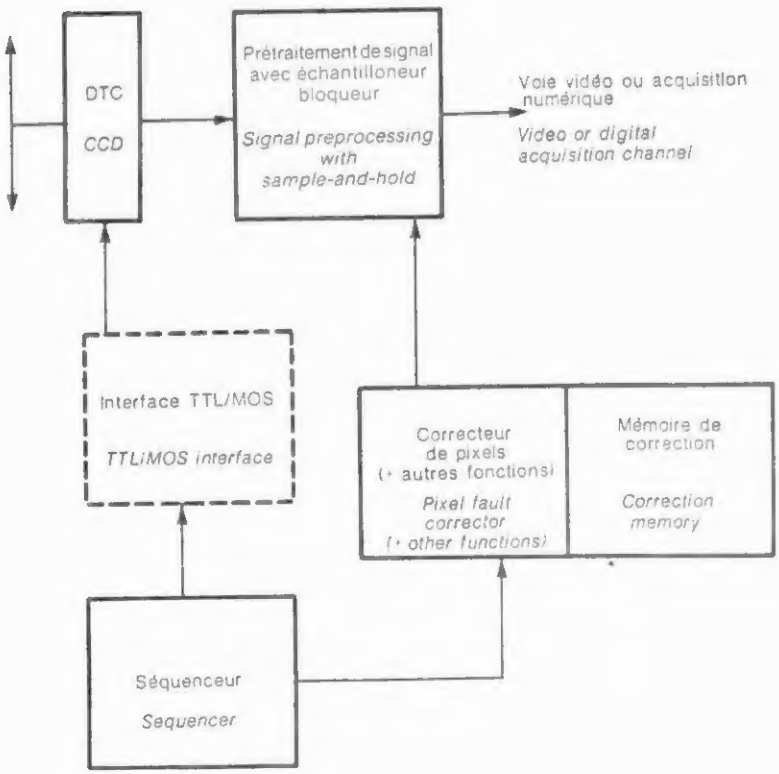
These integrated circuits, based on an advanced VSLI design, are developed specifically for Thomson-CSF frame-transfer area-array CCD image sensors.

Characterized by their ease of use, low power consumption and high degree of miniaturization, they form the basis of state-of-the-art CCD cameras. The models described enable all essential sensor functions to be achieved, from clock sequencing to output signal shaping.

The integrated circuits can be supplied in military and industrial quality classes.

Organisation d'une caméra à circuits intégrés spéciaux

Organization of integrated circuits for implementing a TV camera



CARTES POUR DTC MATRICIELS
AREA-ARRAY CCD DRIVE BOARDS

Organisation d'une caméra utilisant des cartes de mise en œuvre

Organization of drive boards for implementing a camera

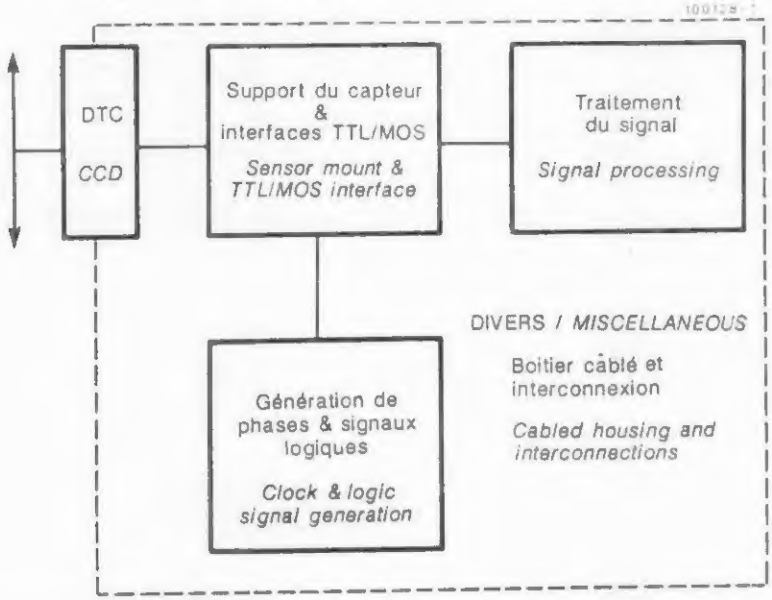


Tableau de correspondance des cartes de mise en œuvre/ Capteur DTC matriciel

Drive board/Area Array CCD correspondence table

Référence *capteur* *Sensor reference*	Cartes de mise en œuvre, selon fonction *Drive boards, according to function*			Boîtier *Housing*
	Interface TTL/MOS *(1)* *TTL/MOS interface (1)*	Génération des phases et signaux logiques (1) *Clock and logic signal generation (1)*	Traitement de *signal (1)* *Signal processing (1)*	
TH 7852	TH 7960-1	TH 7961	TH 7962 ou/*or* TH 7963	TH 7965H1
TH 7862A	TH 7966-2 (ex THX 5008-5)			
TH 7863	TH 7966-3			
TH 7864	THX 5008-8			
TH 7866	THX 5008-9			
TH 7882	THX 5008-5			
THX 31510A	TH 7960-6 (ex THX 5007-7)	TH 7961-6 (ex THX 5008-3)		

(1) Voir page 4 pour explications/*See page 4 for explanations*

BOITIER/*HOUSING*

TH 7965H1

Caractéristiques

- Interconnection entre cartes (capacité 3 cartes)
- Boîtier câblé permettant de réaliser un kit de caméra (tous modèles)
- Entrées/sorties sur connecteur SUB-D 25 contacts
  Signal Vidéo sur fiche BNC

Characteristics

- *Interconnection between boards (3-board capacity)*
- *Cabled housing for camera kit (any model)*
- *Inputs/outputs on SUB-D 25-pin connector*
- *Video signal on BNC connector*

TABLEAU DE SÉLECTION POUR CARTES

SUPPORT CAPTEUR / INTERFACE / GENERATION DE SIGNAUX DE COMMANDE ET DE SYNCRONISATION

QUICK REFERENCE TABLE FOR

SENSOR MOUNT / INTERFACE / DRIVE & SYNC SIGNAL GENERATION DRIVE BOARDS

Fonctions	*Functions*		TH 7960-1 TH 7960-6	TH 7961	TH 7961-6	TH 7966-3	TH 7966-2	THX 5008-8	THX 5008-9
Interface TTL/MOS	*TTL/MOS interfacing*		•			•	•	•	•
Génération des tensions de polarisation	*Bias voltage generation*		•			•	•	•	•
Echantillonnage/ filtrage/adaptation d'impédance	*Sampling/filtering/ impedance matching*		•			•	•	•	•
Adaptation opto-mécanique avec objectif monture "c"	*Opto-mechanical interfacing with "c" type lens mount*		•			•	•	•	•
Génération de signaux de commande et de synchronisation (horloge externe possible)	*Drive and SYNC Signal generation* (ext. clock *possible)*	CCIR TV		•		•	•	•	
		EIA RS170 TV							•
		SINGLE FIELD		•	•	•	•		

TABLEAU DE SELECTION POUR CARTES DE TRAITEMENT DU SIGNAL DE SORTIE VIDEO

QUICK REFERENCE TABLE FOR VIDEO OUTPUT SIGNAL PROCESSING BOARDS

Fonctions	*Functions*	TH 7962	TH 7963
Amplification du signal vidéo	*Video signal amplification*	•	•
Conversion A/N 1 bit, seuil variable	*1-bit A/D conversion with threshold*	•	•
Correction de GAMMA	*GAMMA correction*	•	
Voie vidéo TV	*TV video channel*	•	
Voie vidéo X, Y, Z pour moniteur électrostatique	*X, Y, Z video channel for electrostatic monitor*		•

Caractéristiques communes à toutes cartes pour DTC matriciels

- Dimensions : 160 mm x 100 mm (format "Europe")
- Alimentations utilisées : + 15 V ; - 15 V ; + 5 V ;
- Connecteur : Europe DIN 41612/C-64M

Characteristics common to all area array CCD drive boards

- *Dimensions : 160 mm x 100 mm (Eurocard format)*
- *Power supply req. : + 15 V ; - 15 V ; + 5 V ;*
- *Connector : Europe DIN 41612/C-64M*

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TUBES ELECTRONIQUES

Niveau de Qualité "H" - ne concerne que les modèles TH 7861 et TH 7862 (pour $V_{sortie} \leqslant V_{SAT}$)

"H" Quality Grade- only for the TH 7861 and TH 7862 (for $V_{output} \leqslant V_{SAT}$)

Sur toutes zones : pas de colonnes visibles · *On all zones : no visible columns*

Conditions : T = 50 °C; $\overline{V}_{sortie} = \overline{V}_{output}$ = 50 mV
Conditions :

Spécification des défauts : *Blemish specifications :*	Zone 1		Zone 2		Zone 3	
Type (blanc ou noir) *Type (black or white)*	B *W*	N *B*	B *W*	N *B*	B *W*	N *B*
Nombre *Number*	0	2	5 (N + B) *5 (B + W)*		5 (N + B) *5 (B + W)*	
Surface en nombre de pixels *Area in number of pixels*	–	1	1	4	4	4
Amplitude d'un pixel singulier rapporté aux pixels adjacents, α (mV) *Amplitude of single pixel w.r.t. adjacent pixels α (mV)*	$5 < \alpha$	$5 < \alpha \leqslant 10$	$5 < \alpha \leqslant 15$	$10 < \alpha \leqslant 20$	$5 < \alpha \leqslant 20$	$10 < \alpha \leqslant 20$

DÉFINITION DES ZONES

DEFINITION OF ZONES

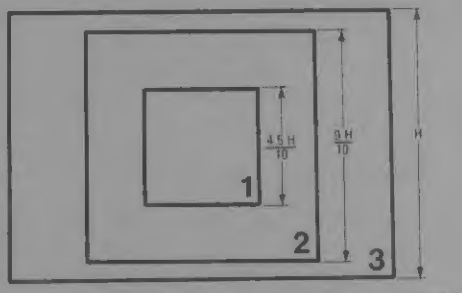

Tableau de correspondance circuit intégré / Capteur DTC matriciel
Integrated circuit / Area Array CCD sensor correspondence table

Référence Capteur *Sensor reference*	Circuits integré selon fonction *Integrated circuit according to function*			
	Séquenceur *Sequencer*	Interface TTL/MOS *TTL/MOS interface*	Correcteur de pixel *Pixel corrector*	Prétraitement de signal *Signal proprocessing*
TH 7852	TH 7990	Non nécessaire *Non necessary*	TH 7993 (1)	TH X33504*
TH 7862A TH 7863 TH 7882		TH 7991		
TH 7864 TH 7866	TH 7994*	TH 7995*		

* En développement - *In development*

Caractéristiques

TH 7990 et TH 7993

- Boîtier plat 44 passages plastique ou céramique
- Alimentation utilisée : − 5 V

TH 7991 et TH X33504

- Microcartes CMS
- Alimentations utilisées : + 5 V et + 15 V

Characteristics

TH 7990 and TH 7993

- *44 pin package plastic leaded chip carrier or ceramic leadless clip carrier*
- *Power supply required : + 5 V*

TH 7991 and TH X33504

- *SMT microboards*
- *Power supply required : + 5 V et + 15 V*

(1) Pour la fonction de correction de pixels, le TH 7993 nécessite une mémoire dédiée, vendue en option avec le DTC matriciel.

Les références à employer lors de la commande d'un capteur associé au circuit de correction des pixels sont donc :

- TH 78__ CD_ + MEM (modèle du DTC matricel + mémoire dédiée)
- TH 7993

Lorsqu'un DTC matriciel est commandé "+ MEM", il sera livré avec une mémoire pré-progammée, individuellement adaptée au DTC (avec identification).

(1) For pixel correction, the TH 7993 requires a dedicated memory, sold on option with the CCD area-array sensor.

The ordering codes for a sensor and its pixel correction circuit is therefore :

- *TH 78__ CD_ + MEM (CCD area-array model + dedicated MEMORY)*
- *TH 7993*

When a area-array CCD is ordered "+ MEM", it is delivered with an individually matched, pre-programmed memory (with an identifying reference).

THOMSON-CSF
TUBES ELECTRONIQUES

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DISPOSITIFS PHOTOSENSIBLES MATRICIELS DTC

AREA ARRAY CCD IMAGE SENSORS

NIVEAUX DE QUALITÉ D'IMAGE

La position des défauts est aléatoire. Un pixel est considéré comme défectueux si son niveau de tension est à plus de 10 % de VSAT au-dessus ou au-dessous des pixels voisins, la mesure étant effectuée à un niveau moyen de VSAT/2.

La taille d'une zone défectueuse est exprimée par sa plus grande dimension dans chacune des deux directions (X-Y) mesurée en nombre de points adjacents sur une trame.

IMAGE QUALITY GRADES

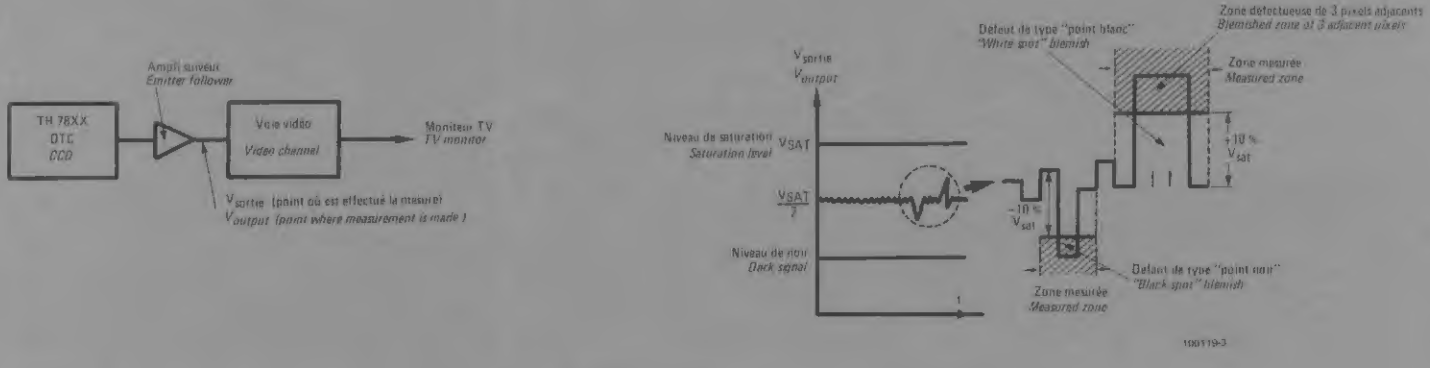
Blemishes are randomly distributed. A pixel is considered blemished if its voltage level differs from that of its neighbors by more than 10 % of VSAT, the measurement being made at VSAT/2.

The size of a blemish is expressed by the largest dimension in both directions (X-Y) and is measured in terms of adjacent pixels on a frame.

NIVEAU DE QUALITÉ D'IMAGE *IMAGE QUALITY GRADE*	NIVEAU A *GRADE A*				NIVEAU B *GRADE B*				NIVEAU C *GRADE C*			
	TH 7852	TH 7861	TH 7862	TH 7882	TH 7852	TH 7861	TH 7862	TH 7882	TH 7852	TH 7861	TH 7862	TH 7882
Nombre de zones défectueuses, max. *Number of blemish zones, max.*	5	10	10	20	15	15	15	30	25	25	25	50
Taille des zones défectueuses, max. (pixels) *Size of blemish zone, max. (pixels)*	3 x 3	4 x 4	4 x 4	4 x 4	5 x 5	6 x 6	6 x 6	6 x 6	8 x 8	8 x 8	8 x 8	8 x 8
Est considéré comme une colonne défectueuse tout défaut vertical d'une taille supérieure à celle de la zone défectueuse, définie ci-dessus, pour un niveau de qualité d'image et un produit donné. *A defective column is defined as a vertical blemish whose height exceeds that of the above defined blemished zone for a corresponding image quality grade and model.*												
Nombre de colonnes défectueuses, max. (largeur 1 pixel) *Number of defective columns, max. (width 1 pixel)*	0	0	0	0	2	0	4	0	4	8	4	8
Nombre des colonnes défectueuses adjacentes, max. *Number of adjacent defective columns, max.*	0	0	0	0	1	0	1	0	2	2	2	2

Les mesures de la tension de sortie, Vsortie, sont prises à la sortie d'un amplificateur suiveur, et avant la voie vidéo.

The output voltage, Vout, is measured at the output of an emitter follower, and before the video channel.



DTE 120 B

THOMSON-CSF
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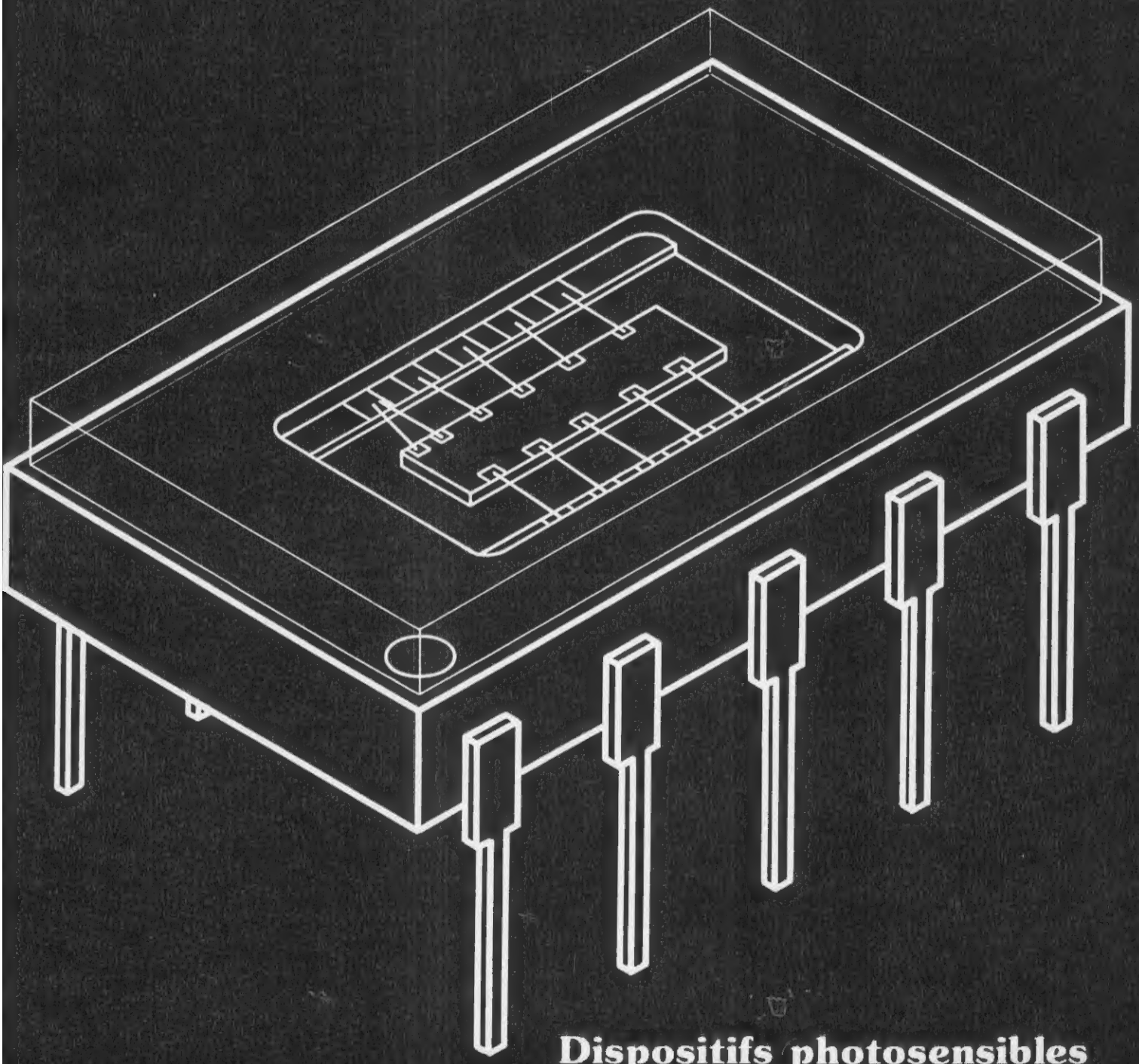
Linear Array Charge-Coupled Device (CCD) Image Sensors



Dispositifs photosensibles linéaires à transfert de charge (DTC)

DISPOSITIFS PHOTOSENSIBLES LINÉAIRES A TRANSFERT DE CHARGE

DESCRIPTION

Les DTC linéaires THOMSON-CSF sont constitués pour l'essentiel d'un réseau linéaire de photodiodes, formant la partie centrale du dispositif, associée à deux registres latéraux à transfert de charge, disposés de part et d'autre de la zone photosensible et chargés d'évacuer jusqu'à un circuit final de lecture, les charges créées dans les photodiodes par le faisceau lumineux incident.

La technologie n-MOS canal enterré, à deux niveaux de grille silicium polycristallin utilisée pour leur réalisation, l'emploi de substrats spécifiques de haute qualité (désignés par la lettre "Z" en fin de référence) ainsi qu'un contrôle sévère à toutes les étapes de fabrication, permettent de proposer des dispositifs de hautes performances caractérisés par :

- une capacité de stockage importante alliée à de faibles niveaux de bruits résiduels, permettant d'obtenir des valeurs de dynamique élevées (pouvant aller jusqu'à 7000 : 1),
- une excellente efficacité de transfert dans une gamme de fréquences étendue (inefficacité typique : 2.10^{-5}/étage) permettant un large choix de temps d'intégration et de fréquences de lecture, de quelques centaines de kHz à quelques dizaines de MHz,
- une haute sensibilité et une excellente qualité de la réponse spectrale, de 400 à 1100 nm (visible et proche IR), ainsi que de bonnes performances de résolution (Fonction de Transfert de Modulation), y compris dans le proche infrarouge, du fait de la structure employée alliant photodiodes et faible épaisseur de la zone optiquement active,
- une excellente uniformité de la réponse (typiquement ± 5 %) sur toute la zone photosensible, dans l'obscurité comme sous éclairement, avec un nombre réduit de défauts isolés (points singuliers) noirs et blancs.

De plus, ces capteurs présentent les avantages de compacité, robustesse, durée de vie et faible consommation, inhérents aux circuits intégrés n-MOS.

La plupart d'entre eux possèdent une logique interne incorporée délivrant des signaux :

- de remise à niveau des circuits de lecture,
- d'échantillonnage et de maintien des signaux de sortie,

qui permettent de simplifier leur mise en œuvre à partir de deux signaux d'horloge externes :

- ΦP : Impulsion de transfert commandant le passage des charges de la zone photosensible vers les registres et définissant la durée du temps d'intégration entre transferts successifs.
- ΦT : Horloge de commande des registres, définissant la cadence de lecture des charges et donc la cadence de délivrance des informations.

De par leur conception ces capteurs présentent une grande souplesse de mise en œuvre, selon le type d'applications considérées :

- remise à niveau interne ou externe,
- échantillonnage de sortie interne actif ou non,
- possibilité de sommation des pixels adjacents (accroîssement de la sensibilité au détriment de la résolution).

LINEAR ARRAY CCD IMAGE SENSORS

DESCRIPTION

THOMSON-CSF linear CCD image sensors essentially comprise a linear photodiode array, forming the central portion of the device, and analog shift registers located either or side. The shift registers transfer the charges generated in the photodiodes by the incident illumination into the final readout circuit.

By virtue of their two-layer polysilicon n-MOS buried-channel technology, high-quality, special-purpose substrates (designated by a "Z" at the end of their reference) and tight quality control at all fabrication stages, Thomson-CSF linear array CCD image sensors offer:

- *large storage capacity with low residual noise level, leading to high dynamic range values (up to 7000:1),*
- *excellent charge transfer efficiency over a wide range of frequencies (typical inefficiency: 2×10^{-5} per stage), giving a large choice of integration periods and data output rates, from a few kHz to several tens of MHz,*
- *high sensitivity and spectral response from 400 to 1100 nm (visible to near IR) as well as good resolution performance (modulation transfer function). This performance is maintained in the near infrared owing to the sensor structure that combines photodiodes and a thin optically active zone,*
- *excellent response uniformity (typically ± 5%) throughout the photosensitive zone - both in darkness and illumination - with a small number of isolated defects (black or white spikes).*

The sensors also share the advantages common to n-MOS integrated circuits: compactness, ruggedness, unlimited lifetime and low power drain.

Most models possess on-chip logic for:

- *readout register reset, and*
- *output signal sample-and-hold*

which simplifies their operation by requiring only two external clocks:

- *Φ P: transfer pulse controlling the passage of charge from the photosensitive zone to the shift registers. This clock defines the integration time period between successive transfers.*
- *Φ T: transfer clock defining the charge readout frequency, and hence the data output rate.*

Their design offers a large degree of flexibility for different possible circuit applications:

- *external or internal reset,*
- *internal sample-and-hold, active or disabled,*
- *possibility of pixel pairing (to increase sensitivity at the expense of resolution).*

TABLEAU RÉSUMÉ DES DTC LINÉAIRES (valeurs typiques)
LINEAR CCD QUICK-REFERENCE TABLE (Typical Values)

CARACTÉRISTIQUES *CHARACTERISTICS*	Unités *Units*	TH 7806 CD CDZ	TH 7802 ACDZ	TH 7801 ACDZ	TH 7831 CDZ	TH 7803 ACDZ	TH 7811 CDZ	TH 7832 CDZ ▩	TH 7804 CDZ	TH 7805 ACDZ	TH X31510 CDZ (2)
PHYSIQUE - *PHYSICAL*											
Nombre de photoéléments *Nombre of photoelements*		256	1024	1728	1728	1728	1728	2 x 2048 (3)	1024	2048	4096
Dimensions du photoélément (LxH) *Pixel dimensions (WxH)*	µm x µm	13 x 13	13 x 13	13 x 13	13 x 39	10 x 13	13 x 13	13 x 750	13 x 13	13 x 13	7 x 7
Pas du photoélément *Pixel pitch*	µm	13	13	13	13	10	13	13	13	13	7
Longueur photosensible *Photosensitive length*	mm	3.33	13.31	22.46	22.46	17.28	22.46	26.62	13.31	26.62	28.68
Boîtier (DIL) : largeur/broches *Package (DIL): width/pins*		0.3"/10	0.6"/24	0.6"/24	0.6"/24	0.6"/24	0.6"/24	0.6"/20	0.6"/24	0.6"/28	0.6"/28
ÉLECTRIQUE - *ELECTRICAL*											
Fréquence de sortie (max.) *Data output rate (max.)*	MHz	2	2	2	2	2	2	10	15	20	40
Tension continue du signal vidéo *Video signal DC level*	V	8	8	8	8	8	8	11	8	10	11
Impédance de sortie *Output impedance*	Ω	1000	500	500	1000	1000	500	500	500	500	1000
Nombre de phases de commande *Number of control clocks*		2	2	2	3	2	2	3	2	2	3
Consommation *Power drain*	mW	80	100	100	100	100	100	150	150	150	200
Tension d'alimentation *Power supply voltage*	V	13	14	14	13	13	14	15	15	15	15
ELECTROOPTIQUE : ***ELECTROOPTICAL:***	**T = 25 °C - Conditions de polarisation typiques - Source 2854 K + Filtre IR BG 38** ***T = 25°C - Typical bias voltages - 2854 K source + BG 38 IR filter***										
Tension vidéo à saturation *Video voltage at saturation*	V	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.0	0.8
Réponse *Response*	V/µJ/cm²	6.0	6.0	6.0	17.0	4.5	6.0	200	6.0	4.5	1.5
Bruit temporel dans l'obscurité *Temporal noise in darkness*	µV (r.m.s)	350	350	350	350	350	350	600	400	250	400
Dynamique : S/B (r.m.s) *Dynamic range: S/N (r.m.s)*		6000	6000	6000	6000	6000	6000	3000	6000	8000	2000
FTM à fréquence Nyquist *MTF at Nyquist frequency*	%	60	60	60	60	60	60	50	50	60	50
Non-uniformité de réponse (points singuliers exclus) *Response non-uniformity (spikes excluded)*	%	± 5	± 5	± 5	± 5	± 5	± 5	± 10	± 5	± 5	± 5
Valeur moyenne de la tension d'obscurité V_{so} *Average dark signal voltage V_{so}*	mV	0.5	0.5	0.5	0.5	0.5	0.5	10	0.5	0.5	0.5
Non uniformité du signal d'obscurité ΔV_{so} *Dark signal non-uniformity ΔV_{so}*	mV	0.5	0.5	0.5	0.5	0.5	0.5	10	0.5	0.5	0.5
Carte de mise en œuvre utilisable *Compatible drive module*		TH 7931C	TH 7931 B	TH 7931 B	TH 7931 C	TH 7931 B	TH 7931 B1	TBD*	TH X1061	TH 7932 (ex TH X1074)	TBD*

* En développement (1) Modèle équipé d'un dispositif d'antiblooming (100 x E_{SAT})
(2) Version prototype
▩ Séparation entre les axes des 2 lignes photosensibles = 1250 microns
(4) Nécessite circuit d'adaptation

* *In development* (1) *Model with built-in antiblooming device (100 x I_{SAT})*
▩ *Prototype version*
(3) *Separation between the two linear array axes = 1250 microns*
(4) *Requires adaptor circuit*

ASSURANCE QUALITÉ

Les capteurs photosensibles livrés satisfont à une classe d'assurance qualité standard. Sur demande, des dispositifs répondant à des spécifications particulières - ainsi qu'à des contrôles et des tests de qualité propres à des classes de qualités supérieures - peuvent être fournis (applications spéciales, militaires, spatiales, etc.).

APPLICATIONS

Tous systèmes d'analyse d'image dans le domaine visible et proche infrarouge reposant sur un balayage ligne-par-ligne de l'image, associé à un défilement relatif du capteur par rapport à l'objet analysé, tels que :

- La transmission de documents : télécopie, fac-similé,
- La reconnaissance et le traitement d'images : lecteur optique de caractères, lecteur de codes-barre, lecteur de plans, machines de reprographie, analyseurs d'images fixes ou de microfilms,
- La reconnaissance de formes et l'analyse d'objets : contrôle dimensionnel et métrologie, tri, inspection, détection de défauts,
- La surveillance et l'observation : caméras de surveillance industrielle et de robotique, caméras d'observation par satellite, systèmes d'observation astronomique,
- Les applications scientifiques : analyse spectrale, détection de rayonnement.

En particulier :

- Les capteurs **TH 7801ACDZ, TH 7802ACDZ** et **TH 7803ACDZ** sont destinés aux applications qui requièrent une fréquence de lecture n'excédant pas 2 MHz.
- Les capteurs 1728 photoéléments **TH 7801ACDZ, TH 7803ACD** et **TH 7803ACDZ** sont tout particulièrement adaptés pour la télécopie moyenne définition (8 points/mm).
- Les **TH 7804 CDZ, TH 7805ACDZ** et **TH X31510CDZ** sont dévolus aux applications nécessitant des fréquences de lecture élevées (jusqu'à 20 et 40 MHz), telles que : télécopies et reprographie rapide, reconnaissance optique de caractères, télécinéma.
- Le **TH X31510CDZ** est plus spécialement destiné aux applications qui nécessitent une très haute définition et une grande vitesse d'analyse.
- Le **TH 7831CDZ** et **TH 7832 CDZ,** vue la hauteur de leurs photoéléments et leurs grande sensibilité, sont tout particulièrement adaptés à l'analyse spectrale.
- Le **TH 7811 CDZ,** de par sa caractéristique anti-éblouissement, est destiné à toutes les applications où l'on doit pouvoir accepter de grandes variations des niveaux d'éclairement : flashes, éclairage jour et nuit, etc.

QUALITY ASSURANCE

Image sensors are normally supplied in standard quality assurance classes. Upon request, Thomson-CSF can also supply sensors to custom specifications, as well as models submitted to quality control tests conforming to superior quality classes for special, military or space applications, etc.).

APPLICATIONS

Thomson-CSF linear array CCD image sensors can be used for all image pickup systems operating in the visible and near-infrared spectrum, by line-by-line scanning through relative displacement of the sensor with the scene, such as:

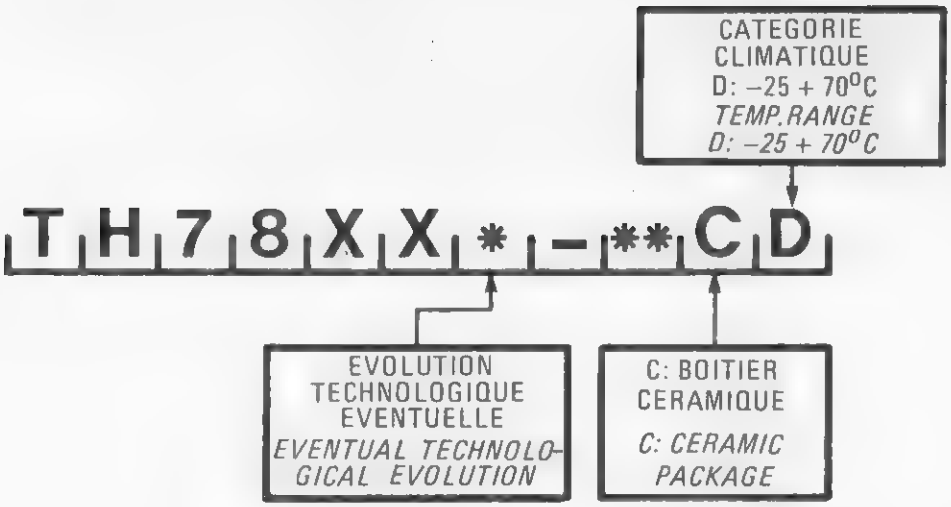
- *Document transmission: telecopy, facsimile,*
- *Image recognition and processing: optical character recognition, bar-code readers, plan readers, electronic publishing, static image and microfilm scanning,*
- *Shape recognition and object analysis: dimensional control, metrology, sorting, inspection, defect detection,*
- *Surveillance and observation: industrial and robotic surveillance cameras, earth observation by satellite, astronomical observation systems,*
- *Scientific applications: spectral analysis, ray analysis, etc.*

In particular:

- *The **TH 7801ACDZ, TH 7802ACDZ** and **TH 7803ACDZ** are aimed at applications not requiring a readout rate above 2 MHz.*
- *The 1728 pixel format of the **TH 7801ACDZ, TH 7803ACD, TH 7803ACDZ** and **TH X31510CDZ** is particularly suited to medium-definition telecopy (8 points/mm).*
- *The **TH 7804 CDZ, TH 7805ACDZ** and **TH X31510CDZ** are destined for high-frequency applications (up to 20 and 40 MHz) such as: fast telecopy and reprography, optical character recognition and telecinema.*
- *The **TH X31510CDZ** is more specifically intended for application requiring a very high definition and the possibility of high-speed scanning.*
- *The **TH 7831CDZ** and **TH 7832 CDZ** are specially designed for spectral analysis, having extended photoelement height, and thus high sensitivity.*
- *The **TH 7811 CDZ,** by its antiblooming characteristics, is intended for all applications involving large light level variations: flashes, day-night lighting conditions, etc.*

DÉSIGNATION DU PRODUIT

PRODUCT DESIGNATION



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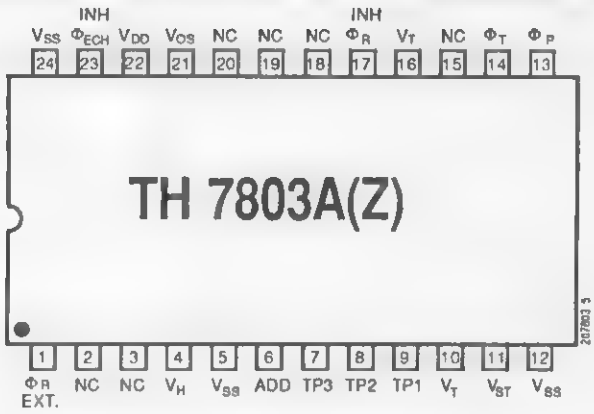
THOMSON-CSF
TUBES ELECTRONIQUES

Linear CCD* Image Sensor

1728 pixels

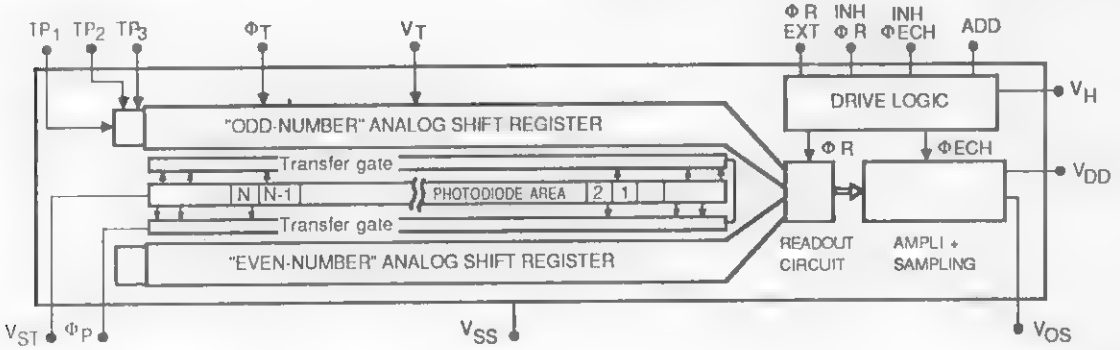


- Pixel size : 10 μm x 13 μm (10 μm pitch)
- Simple operation :
  - two drive clocks
  - Internal sample-and-hold available
  - Dark reference incorporated
- Peak-to-peak output : 2 volts
- High sensitivity, dynamic range and resolution over a wide spectral range : from blue (400 nm) up to Near Infrared (1100 nm), thanks to special semi-conductor process
- Low dark signal
- Dynamic range : 6000:1 (typ.)
- Choice of operating modes for improved flexibility
- 24-pin DIL package

* Charge Coupled Device

PIN IDENTIFICATION

Pin no.	Symbol	Designation
1	Φ_R EXT	External Reset Clock
4	V_H	Internal Logic Supply Voltage
5-12-24	V_{SS}	Substrate Voltage (Ground)
6	ADD	Addition of Odd and Even Pixels (DC Bias)
7-8-9	TP3-TP2-TP1	Test Points
10-16	V_T	Shift Register DC Bias
11	V_{ST}	Photosensitive Zone DC Bias
13	Φ_P	Transfer Clock
14	Φ_T	Shift Register Transport Clock
17	INH Φ_R	Internal Reset Clock Inhibiting Input (DC Bias)
21	V_{OS}	Video Output Signal
22	V_{DD}	Output Amplifier Drain Supply
23	INH Φ_{ECH}	Internal Sampling Clock Inhibiting Input (DC Bias)
2-3-15-18-19-20	NC	No Connection (Do not ground)



NOTE : To simplify sensor operation a drive board has been developed and may be purchased from Thomson-CSF (ref. TH 7931B). This board provides all the necessary electronics : DC supplies, driving clocks and video ouput buffer.

ABSOLUTE MAXIMUM RATINGS

Storage temperature ..... - 55 °C to + 150 °C
Operating temperature ..... - 40 °C to + 70 °C
Maximum voltages :
- Pins : 1, 4, 6, 7, 8, 9, 10, 14, 16, 17, 22, 23 ..... - 0.3 V to + 18 V
- Pins : 11, 13 ..... - 0.3 V to + 16 V
- Pins : 5, 12, 24 ..... 0 V

OPERATING CONDITIONS (T = 25 °C)

Table I - DC Characteristics

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Internal Logic Supply Voltage	V_H	11.4	13	14.5	V
Shift Register DC Bias	V_T	6	6.7	7.5	V
Photosensitive Zone DC Bias	V_{ST}	V_T	-	7	V
Output Amplifier Drain Supply	V_{DD}	11.4	13	14.5	V
Substrate Voltage	V_{SS}	0.0	0.0	-	V
Test Point 1	TP1	-	V_{DD}	-	V
Tests Points 2 and 3	TP2,TP3	-	V_{SS}	-	V

Table II - Drive Clock Characteristics
(See timing diagram - fig.1)

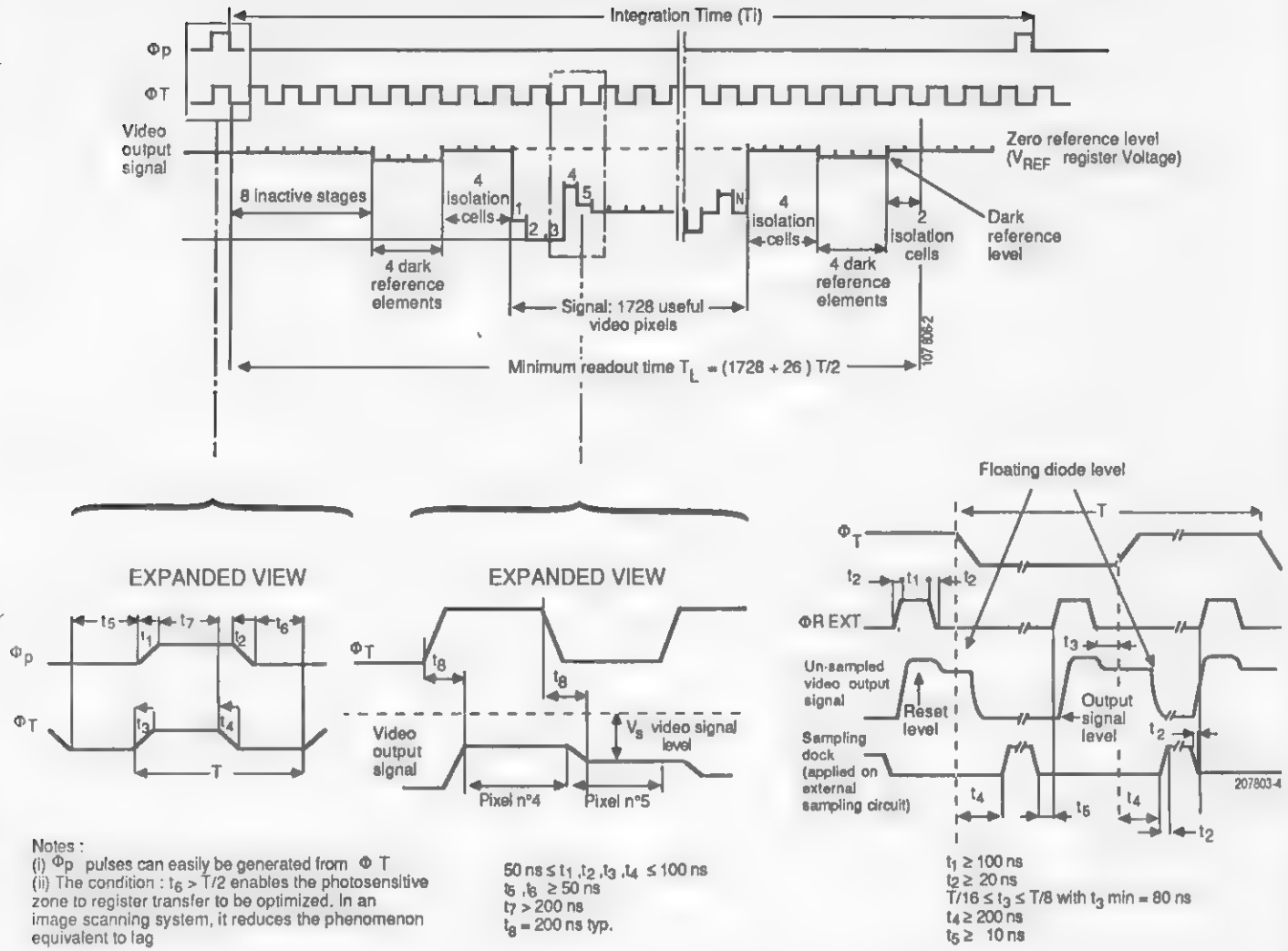
Parameter	Symbol	Logic	Value			Unit
			Min.	Typ.	Max	
Transfer Clock (1)	Φ_P	High	11.4	13	14.5	V
Register Transport Clock (1)	Φ_T					
External Reset Clock (1) (2)	Φ_{REXT}	Low	0.0	0.4	0.6	V
Register Clock Capacitance	$C\Phi_T$		-	550	700	pF
Transfer Clock Capacitance	$C\Phi_P$		-	150	200	pF

(1) Transients under 0.0 V in the clock pulses will lead to charge injection, causing a localized increase in the dark signal. If such spurious negative transients are present, they can be suppressed by inserting a serial resistor of appropriate value (typically 20 to 100 Ω) in the corresponding driver output.
(2) In external reset configuration (Φ_{REXT})

Table III - Static and Dynamic Electrical Characteristics

Parameter	Symbol	Value			Unit	Remark
		Min.	Typ.	Max.		
DC Ouput Level	V_{REF}	5	8	11	V	(5)
Ouput Impedance	Z_s	-	1000	-	Ω	(5)
Single-stage Transfer Efficiency	-	99.992	99.998	-	%	$\bar{V}_{OS}$ = 1V (3)
Max. Data Ouptut Frequency	Fs max.	1.0	2.0	-	MHz	(4) See fig. 2
Input Current on Pins : 7, 8, 9, 10, 11, 13, 14, 16	I_e	-	-	2	µA	Ve = 15 V All other pins : 0V
Input Current on Mode Selection Pins (V_{DD}=VH=15V)	Φ_{REXT} INH Φ_{ECH} ADD	-	-	0.2	mA	Ve = 15 V
	INH Φ_R	- 0.2	-	-	mA	Ve = 0V
Average Current Sink on Φ_T Clock	$I\Phi_T$	-	1.5	-	mA	t_{rise} = 50ns Fs = 2 MHz
Peak Current Sink on Φ_T Clock	$(I\Phi_T)_p$	-	200	-	mA	t_{rise} = 50 ns
Peak Current Sink on Φ_P Clock	$(I\Phi_P)_p$	-	70	-	mA	t_{rise} = 50 ns
Internal Logic Supply Current	I_H	-	3.5	5.0	mA	-
Output Amplifier Supply Current	I_{DD}	-	2.0	5.0	mA	-
Static Power Dissipation	P_D	-	100	150	mW	-

(3) $\bar{V}_{OS}$ = average video output voltage. Measurement excludes first and last pixels.
(4) Fs = $2F\Phi_T$. The minimum clock frequency is limited by the increase in dark signal.
(5) Shorting the video output to V_{SS} or V_{DD}, even temporarily, can permanently damage the ouput amplifier



Notes :
(i) Φp pulses can easily be generated from ΦT
(ii) The condition : $t_6 > T/2$ enables the photosensitive zone to register transfer to be optimized. In an image scanning system, it reduces the phenomenon equivalent to lag

$50\ ns \leq t_1, t_2, t_3, t_4 \leq 100\ ns$
$t_5, t_6 \geq 50\ ns$
$t_7 > 200\ ns$
$t_8 = 200\ ns$ typ.

$t_1 \geq 100\ ns$
$t_2 \geq 20\ ns$
$T/16 \leq t_3 \leq T/8$ with t_3 min = 80 ns
$t_4 \geq 200\ ns$
$t_5 \geq 10\ ns$

Figure 1a - Standard operating configuration (all internal clocks used)

Figure 1b - Operating configuration with external reset ($\Phi_{R\,EXT}$) and / or external sample-and-hold

Figure 1 - Timing diagram

OPERATING MODES

COMPLEMENTARY MODE CONTROL SIGNALS

- **ADD** : Pixel pairing control (allows analog addition of odd and even pixels resulting in a video signal corresponding to 864 pixels of dimensions 20 µm x 13 µm with 20 µm center-to-center spacing).
- **INH** Φ_R :Internal reset clock Φ_R inhibited and replaced by an external reset clock applied on the $\Phi_{R\,EXT}$ input.
- **INH** Φ_{ECH}*: Internal sample-and-hold clock Φ_{ECH} inhibited. An external sample-and-hold circuit may then be substituted for the internal circuit.

The last two modes can be used to derive the utmost performance from TH 7803A(Z) or to add pixels in groups of 3 or more.

* Option on specific request
Please consult Thomson-CSF

Table IV - Selection of Operating Modes

Pin	1	6	17	23
Operating mode	$\Phi_{R\,EXT}$	ADD	INH Φ_R	INH Φ_{ECH}*
Normal mode : All clocks internal	NC or V_{SS}	NC or $\overline{V_{SS}}$	NC or V_{DD}	NC or V_{SS}
Complementary modes: Un-sampled video output signal & internal reset (Φ R)	NC or V_{SS}	NC or $\overline{V_{SS}}$	NC or V_{DD}	V_{DD}
Un-sampled video output signal & external reset (Φ R EXT)	Φ_{REXT}	NC or $\overline{V_{SS}}$	V_{SS}	V_{DD}
Pixel pairing	NC or V_{SS}	V_{DD}	NC or V_{DD}	NC or V_{SS}

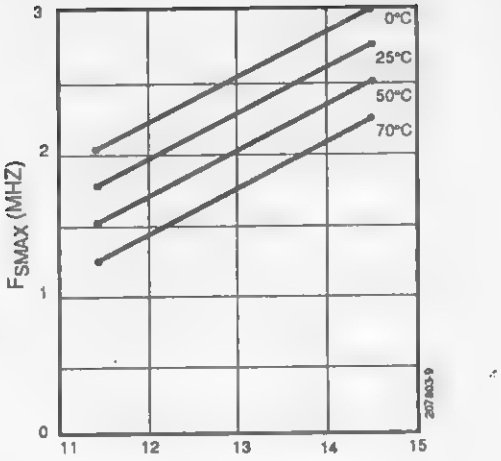
NC = not connected

ELECTROOPTICAL PERFORMANCE

General measurement conditions :
T_p = 25 °C; Ti = 10 ms; Fs = 1 MHz;
Light source : tungsten filament lamp (2854 K) + IR cut-off filter (Schott KG1 + BG38).
Typical operating conditions; internal clock mode (See table IV).
First and last pixels, as well as dummy elements are excluded from measurement.

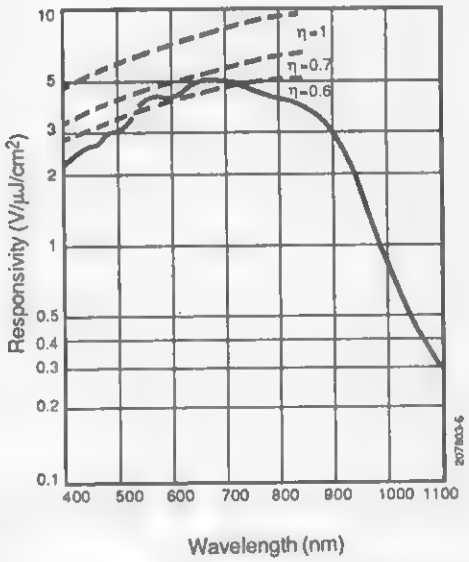
Table V - Electrooptical Performance

Parameter	Symbol	Value			Unit	Remark
		Min.	Typ.	Max.		
Saturation Output Voltage	V_{SAT}	1.3	2.0	3.5	V	(6) (8)
Saturation Exposure	E_{SAT}	-	0.45	-	µJ/cm²	(7)
Responsivity	R	3.0	4.5	-	V/µJ/cm²	See Fig. 3
Temporal Noise in Darkness		-	350	-	µV(rms)	-
Dynamic Range (relative to rms noise)	DR	3000	6000	-	-	-
Average Dark Signal	V_{DS}	-	0.5	8	mV	(6)
Dark Signal Non-Uniformity	DSNU	-	0.5	8	mV	-
Amplitude of Signal Defects in Darkness	-	-	-	80	mV	-
Photo Response Non-Uniformity : - Single Defects Excluded - Peak-to-peak	PRNU	- -	±5 -	- ±15	% $\bar{V}_{OS}$	$\bar{V}_{OS}$=1volt
Contrast Transfer Function at FN (50 lp/mm)	CTF	-	60	-	%	See Fig. 4



Power Supply voltage (V)
V_{DD}= V_H

Figure 2 - Max. data output rate vs. supply voltage (Typical curves)



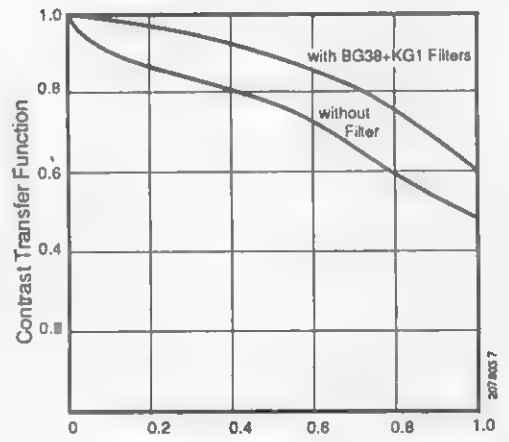
Wavelength (nm)

Figure 3 - Typical spectral response

ELECTROOPTICAL PERFORMANCE WITHOUT INFRARED CUT-OFF FILTERING

The TH 7803A(Z)'s special semiconductor process enables it to exploit the silicon's high near infrared sensitivity while maintaining good imaging performance in terms of response uniformity and resolution. Typical changes in performance with and without IR filtering are summarized below.

	With IR cut-off Filter	No IR cut-off Filter
Average video signal due to a given scene illumination	V_{OS}	V_{OS} x 6
PRNU (Single Defects Excluded)	±5 %	±5 %
CTF at Nyquist frequency	60 %	50 %

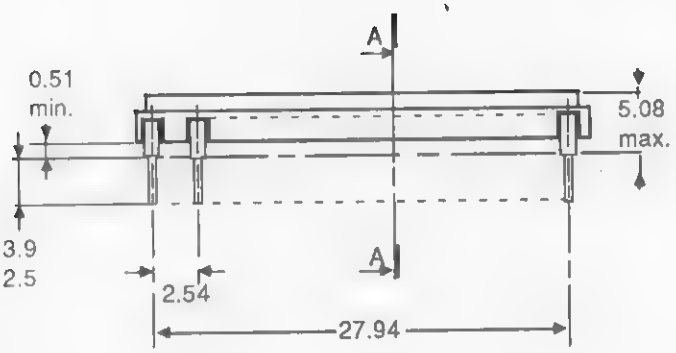


Normalized Spatial Frequency (F/FN)

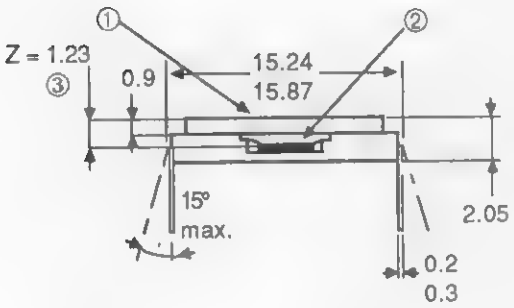
Figure 4 - CTF Typical curves (2854K source)

(6) Value measured with respect to signal zero reference level.
(7) For T_i = 10 ms, the corresponding illumination is 45 µW/cm²
(8) Conversion factor i.e. video output signal / readout charge is typically 1.6 µV/e⁻

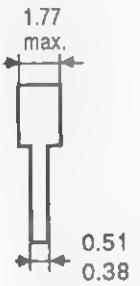
OUTLINE DRAWING

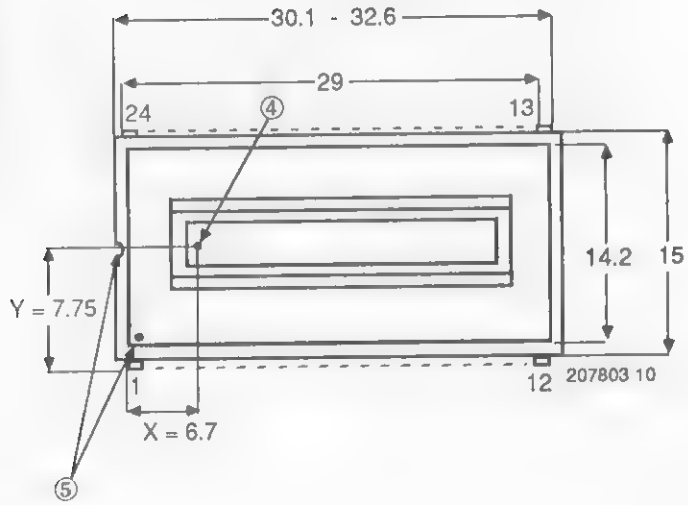


AA CROSS-SECTION



PIN DETAIL





① Window
② Photosensitive area
③ Optical distance between external face of window and photosensitive area
④ Pixel n°1 (first useful pixel in the video line defined by its X,Y,Z coordinates)
⑤ Index (notch or dot)

Dimensions in mm

ORDERING CODES

Product markings are detailed in selection guide DTE-120
The ordering code for standard product is

TH 7803 ACD Z

- C : Ceramic substrate
- D : Temperature range : - 25°C to + 70°C (other ranges may be available)
- Z : Special Near Infra Red optimized substrate

THOMSON-CSF
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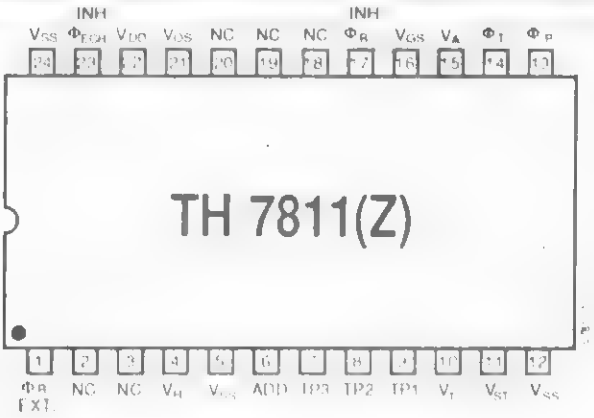
TH 7811(Z)

TENTATIVE

Linear CCD* Image Sensor

1728 pixels With Antiblooming

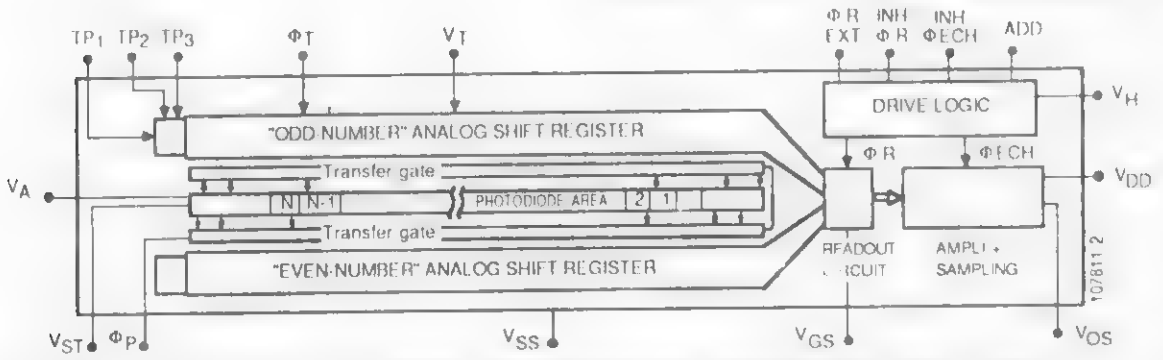


- Pixel size : 13 μm x 13 μm (13 μm pitch)
- Simple operation :
  - two drive clocks
  - Internal sample-and-hold available
  - Dark reference incorporated
- Peak-to-peak output : 2 volts
- High sensitivity, dynamic range and resolution over a wide spectral range : from blue (400 nm) up to Near Infrared (1100 nm), thanks to special semi-conductor process
- Low dark signal
- Dynamic range : 6000:1 (typ.)
- Choice of operating modes for improved flexibility
- 24-pin DIL package
- Similar to TH 7801A except for antiblooming function

* Charge Coupled Device

PIN IDENTIFICATION

Pin no	Symbol	Designation
1	Φ_R EXT	External Reset Clock
4	V_H	Internal Logic Supply Voltage
5-12-24	V_{SS}	Substrate Voltage (Ground)
6	ADD	Addition of Odd and Even Pixels (DC Bias)
7-8-9	TP3 TP2 TP1	Test Points
10	V_T	Shift Register DC Bias
11	V_{ST}	Photosensitive Zone DC Bias
13	Φ_P	Transfer Clock
14	Φ_T	Shift Register Transport Clock
15	V_A	Blooming Control DC Bias
16	V_{GS}	Output Gate DC Bias
17	INH Φ_R	Internal Reset Clock Inhibiting Input (DC Bias)
21	V_{OS}	Video Output Signal
22	V_{DD}	Output Amplifier Drain Supply
23	INH Φ_{ECH}	Internal Sampling Clock Inhibiting Input (DC Bias)
2-3 18-19-20	NC	No Connected (Do not ground)



NOTE : To simplify sensor operation a drive board has been developed and may be purchased from Thomson-CSF (ref. TH 7931B1). This board provides all the necessary electronics : DC supplies, driving clocks and video ouput buffer

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ABSOLUTE MAXIMUM RATINGS

Storage temperature	- 55 °C to + 150 °C
Operating temperature	- 40 °C to + 70 °C
Maximum voltages :	
- Pins : 1, 4, 6, 7, 8, 9, 10, 14, 16, 17, 22, 23	- 0.3 V to + 18 V
- Pins : 11, 13	- 0.3 V to + 16 V
- Pins : 5, 12, 24	0 V

OPERATING CONDITIONS (T = 25 °C)

Table I - DC Characteristics

Parameter	Symbol	Value Min.	Typ.	Max.	Unit
Internal Logic Supply Voltage	V_H	13.5	14	14.5	V
Shift Register and Output Gate DC Bias	V_T, V_{GS}	6	6.4	6.8	V
Photosensitive Zone DC Bias	V_{ST}	5.5	V_T	7	V
Output Amplifier Drain Supply	V_{DD}	13.5	14	14.5	V
Substrate Voltage	V_{SS}	0.0	0.0	-	V
Test Point 1	TP1	-	V_{DD}	-	V
Tests Points 2 and 3	TP2,TP3	-	V_{SS}	-	V
Blooming Control DC Bias	V_A	With AB : 5.4V Without AB : 3V			(3)

Table II - Drive Clock Characteristics (See timing diagram - fig.1)

Parameter	Symbol	Logic	Value Min	Typ	Max	Unit
Transfer Clock (1)	Φ_P	High	12	12.5	13	V
Register Transport Clock (1)	Φ_1					
		Low	0.0	0.4	0.6	V
External Reset Clock (1) (2)	Φ_{REXT}					
Register Clock Capacitance	$C\Phi_1$		-	650	850	pF
Transfer Clock Capacitance	$C\Phi_P$		-	150	200	pF

(1) Transients under 0.0 V in the clock pulses will lead ■ charge injection, causing a localized increase in the dark signal. If such spurious negative transients are present, they can be suppressed by inserting a serial resistor of appropriate value (typically 20 to 100 Ω) in the corresponding driver output.

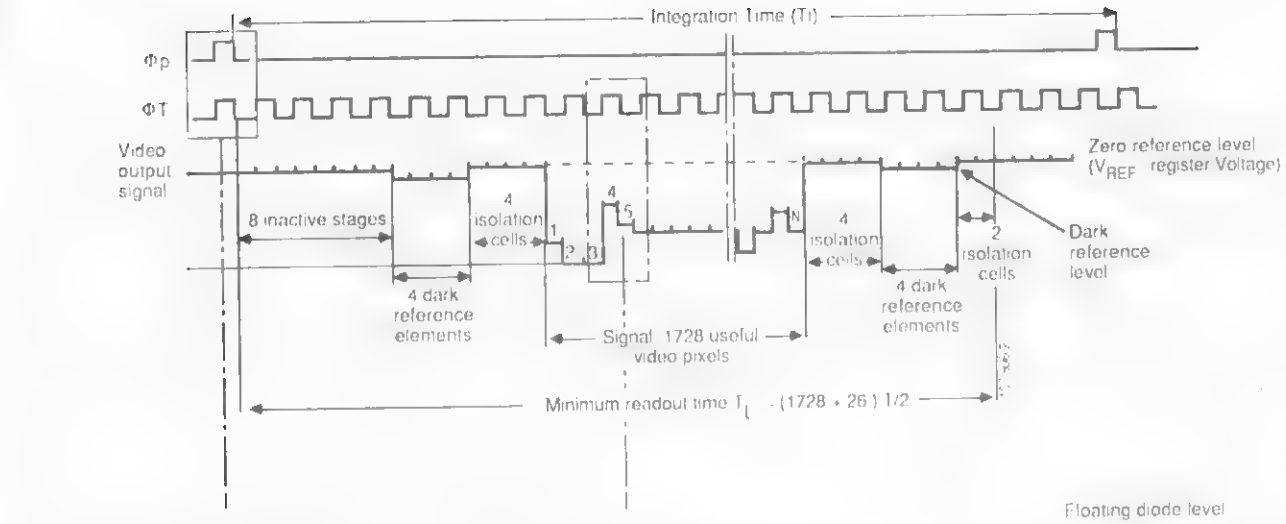
(2) In external reset configuration (Φ_{REXT})

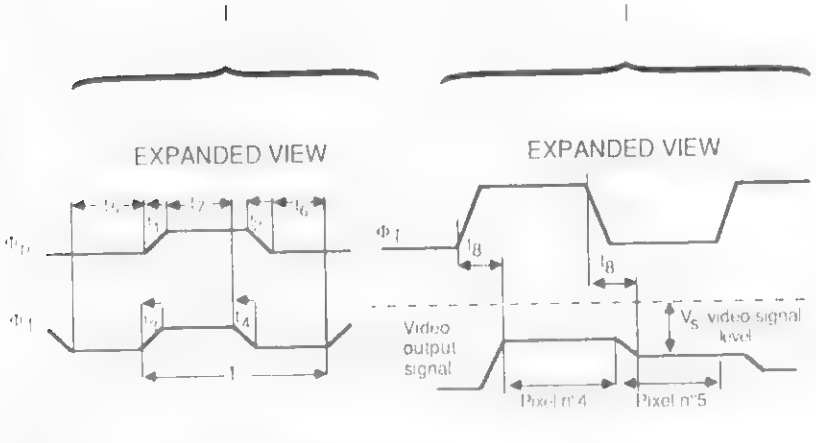
(3) Typical : Exact value to be adjusted depending on device and V_{OS} max desired

Table III - Static and Dynamic Electrical Characteristics

Parameter	Symbol	Value Min	Typ.	Max.	Unit	Remark
DC Ouput Level	V_{RF1}	5	8	11	V	(6)
Ouput Impedance	Z_s	-	500		Ω	(6)
Single-stage Transfer Efficiency		99.992	99.998		%	V_{OS} = 1V (4)
Max. Data Ouptut Frequency	Fs max.	1.0	2.0	-	MHz	(5) See fig. 2
Input Current on Pins : 7, 8, 9, 10, 11, 13, 14, 16	I_e	-	-	2	µA	Ve = 15 V All other pins : 0V
Input Current on Mode Selection Pins (V_{DD}=VH=15V)	Φ REXT INHΦ ECH ADD	-	-	0.2	mA	Ve = 15 V
	INH Φ_R	-0.2	-	-	mA	Ve = 0V
Average Current Sink on Φ_T Clock	$I\Phi_T$	-	1.8	-	mA	t_{rise} = 50ns Fs = 2 MHz
Peak Current Sink on Φ_T Clock	$(I\Phi_T)_p$	-	240	-	mA	t_{rise} = 50 ns
Peak Current Sink on Φ_P Clock	$(I\Phi_P)_p$	-	70	-	mA	t_{rise} = 50 ns
Internal Logic Supply Current	I_H	-	3.5	5.0	mA	-
Output Amplifier Supply Current	I_{DD}	-	2.0	5.0	mA	-
Static Power Dissipation	P_D	-	100	150	mW	-

(4) V_{OS} = average video output voltage. Measurement excludes first and last pixels.
(5) Fs = 2FΦ_T. The minimum clock frequency is limited by the increase in dark signal.
(6) Shorting the video output ■ V_{SS} or V_{DD}, even temporarily, can permanently damage the ouput amplifier

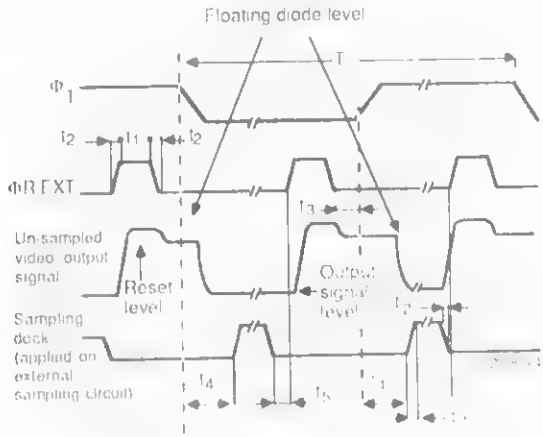




Notes:
(a) ΦP pulses can easily be generated from Φ1
(b) The condition $t_4 = T/2$ enables the photosensitive zone to register transfer to be optimized. In an image scanning system, it reduces the phenomenon equivalent to lag.

50 ns ≤ t1, t2, t3, t4 ≤ 100 ns
t6, t8 ≥ 50 ns
t7 > 200 ns
t8 200 ns typ

Figure 1a - Standard operating configuration (all internal clocks used)



t1 = 100 ns
t2 = 20 ns
T/16 ≤ t3 ≤ T/8 with t3 min = 80 ns
t4 ≥ 200 ns
t5 ≥ 10 ns

Figure 1b - Operating configuration with external reset ($\Phi_{R\,EXT}$) and / or external sample and hold

Figure 1 - Timing diagram

OPERATING MODES

COMPLEMENTARY MODE CONTROL SIGNALS

- **ADD** : Pixel pairing control (allows analog addition of odd and even pixels resulting in a video signal corresponding to 864 pixels of dimensions 26 µm x 13 µm with 26 µm center-to-center spacing).
- **INH Φ_R** :Internal reset clock Φ_R inhibited and replaced by an external reset clock applied on the $\Phi_{R\,EXT}$ input.
- **INH Φ_{ECH}***: Internal sample-and-hold clock Φ_{ECH} inhibited. An external sample-and-hold circuit may then be substituted for the internal circuit.

The last two modes can be used to derive the utmost performance from TH 7811(Z) or to add pixels in groups of 3 or more.

* Option on specific request
Please consult Thomson-CSF

Table IV - Selection of Operating Modes

Pin	1	6	17	23
Operating mode	$\Phi_{R\,EXT}$	ADD	INH Φ_R	INH Φ_{ECH}
Normal mode : All clocks internal	NC or V_{SS}	NC or V_{SS}	NC or V_{DD}	NC or V_{SS}
Complementary modes: Un-sampled video output signal & internal reset (Φ_R)	NC or V_{SS}	NC or V_{SS}	NC or V_{DD}	V_{DD}
Un sampled video output signal & external reset ($\Phi_{R\,EXT}$)	$\Phi_{R\,EXT}$	NC or V_{SS}	V_{SS}	V_{DD}
Pixel pairing	NC or V_{SS}	V_{DD}	NC or V_{DD}	NC or V_{SS}

NC = not connected

ELECTROOPTICAL PERFORMANCE

General measurement conditions :
T_p = 25 °C; Ti = 10 ms; Fs = 1 MHz;
Light source : tungsten filament lamp (2854 K) + IR cut-off filter (Schott KG1 + BG38).
Typical operating conditions; internal clock mode (See table IV).
First and last pixels, as well as dummy elements are excluded from measurement.

Table V - Electrooptical Performance

Parameter	Symbol	Value Min	Typ	Max.	Unit	Remark
Saturation Output Voltage	V_{SAT}	1.3	2.0	3.5	V	V_A = 3V (7) (9)
Saturation Exposure	E_{SAT}	-	0.33		µJ/cm²	V_A 3V (8)
Responsivity	R	4	6	-	V/µJ/cm²	See Fig. 3
Temporal Noise in Darkness		-	350	-	µV(rms)	-
Dynamic Range (relative to rms noise)	DR	3000	6000	-		
Average Dark Signal	V_{DS}	-	0.5	8	mV	(7)
Dark Signal Non-Uniformity	DSNU	-	0.5	8	mV	-
Amplitude of Signal Defects in Darkness		-	-	80	mV	-
Photo Response Non-Uniformity - Single Defects Excluded - Peak to peak	PRNU	-	± 5	- ± 15	% $\bar{V}_{OS}$	$\bar{V}_{OS}$ 1volt
Contrast Transfer Function at FN (38.1p/mm)	CTF		60		%	See Fig. 4

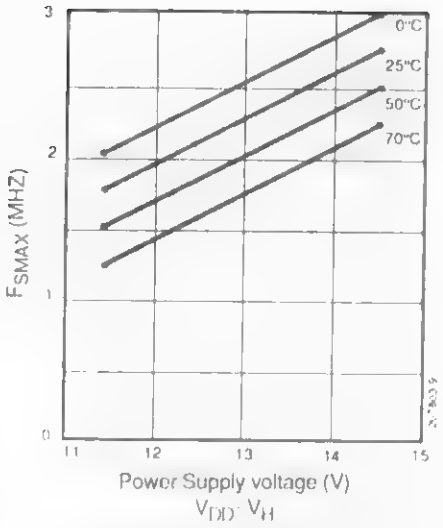


Figure 2 Max. data output rate vs. supply voltage (Typical curves)

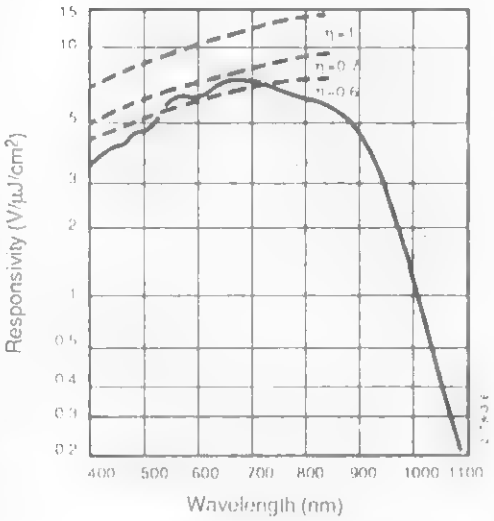


Figure 3 - Typical spectral response

ELECTROOPTICAL PERFORMANCE WITHOUT INFRARED CUT-OFF FILTERING

The TH 7811(Z)'s special semiconductor process enables it to exploit the silicon's high near infrared sensitivity while maintaining good imaging performance in terms of response uniformity and resolution. Typical changes in performance with and without IR filtering are summarized below.

	With IR cut-off Filter	No IR cut off Filter
Average video signal due to a given scene illumination	V_{OS}	V_{OS} x 6
PRNU (Single Defects Excluded)	± 5 %	± 5 %
CTF at Nyquist frequency	60 %	50 %

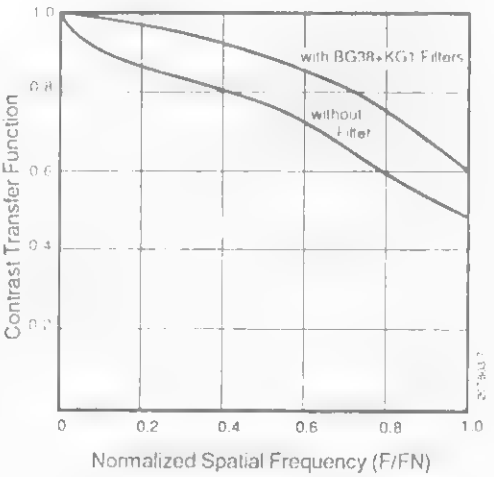


Figure 4 - CTF Typical curves (2854K source)

(7) Value measured with respect to signal zero reference level
(8) For T_i = 10 ms, the corresponding illumination = 33 µW/cm²
(9) Conversion factor i.e. video output signal / readout charge is typically 1.4 µV/e

Blooming Control

Blooming control on the TH 7811(Z) is achieved by associating to each element a MOS transistor controlled by the external V_A DC bias.

The voltage under the photodiodes increases with the quantity of charge they and the associated MOS capacitors store.

At a threshold value, determined by the applied V_A voltage, the MOS transistor is switched on and thereby sweeps away all excess charges. This greatly reduces pollution of neighboring photosites caused by sensor overillumination.

Antiblooming Adjustment

a) Apply + 3V on V_A - this makes antiblooming inoperative.

b) Increase the illumination level till an exposure of 5 x E_{SAT} is reached.

c) Increase the V_A DC bias to a value giving satisfactory blooming reduction.

Activation of the antiblooming control decreases the photodiode storage capacity and consequently the maximum signal at the output.

A good compromise can be found with $(V_{OS})_{max}$ = 2V (about 0.8 V_{SAT} without antiblooming), in which case the V_A value will be 5.4V typically (see fig. 5).

Blooming Efficiency

Fig. 6 shows the TH 7811(Z)'s antiblooming efficiency, evaluated in terms of the diffusion of a 10-pixel diameter dot projected on the array with overexposures respectively of :

- 1 x E_{SAT}
- 5 x E_{SAT}
- 100 x E_{SAT}

At 5 x E_{SAT}, no diffusion occurs.

At 100 x E_{SAT}, only limited diffusion occurs (between 5 and 10 pixels beyond the edge of the original light spot).

Use of a glass window with an antireflective coating on both faces will considerably increase antiblooming efficiency and is strongly recommended.

The characteristics of this coating will depend on the application - please consult Thomson-CSF on this point.

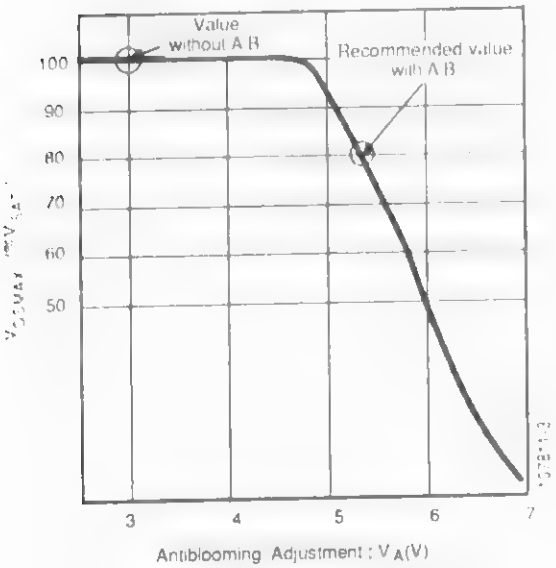


Figure 5 : $V_{OS\ MAX}$ vs V_A Bias

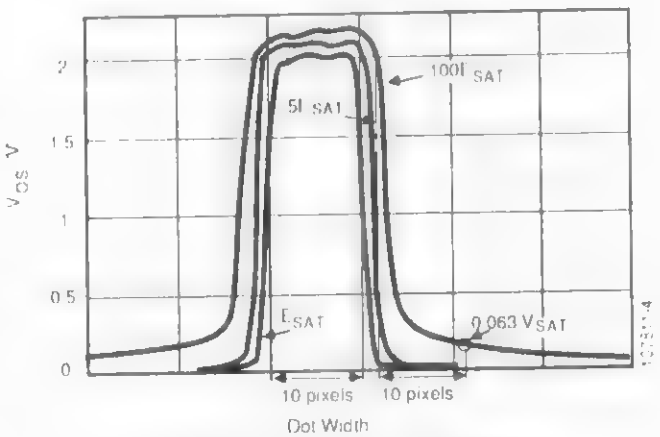
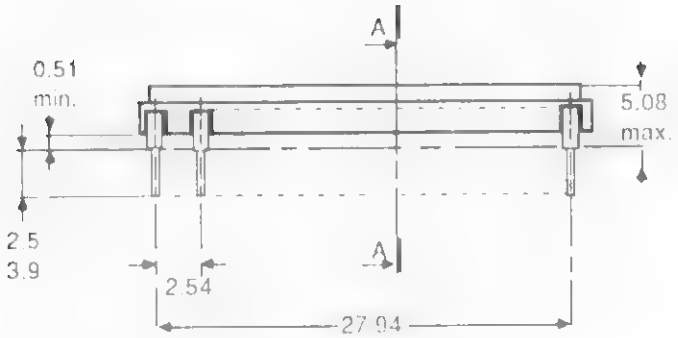
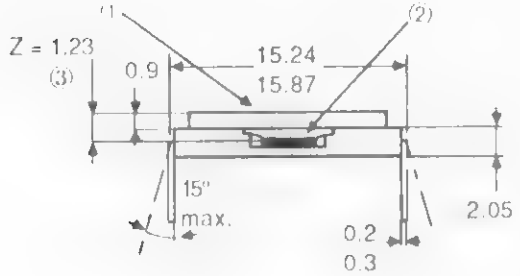


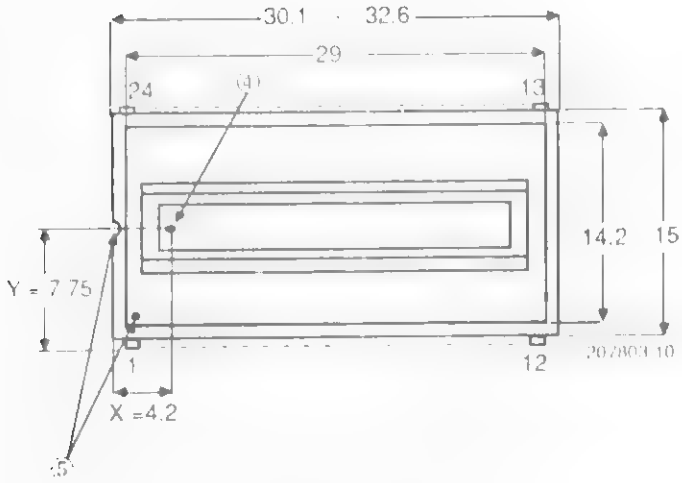
Figure 6 : Antiblooming Efficiency
Conditions : V_A = 5.4V ; Glass Window removed
$(V_{OS})_{max}$ = 2V

OUTLINE DRAWING

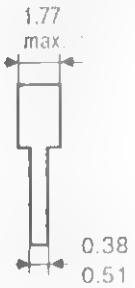


AA CROSS-SECTION





PIN DETAIL



(1) Window
(2) Photosensitive area
(3) Optical distance between external face of window and photosensitive area
(4) Pixel n°1 (first useful pixel in the video line defined by its X,Y,Z coordinates)
(5) Index (notch or dot)

Dimensions in mm

ORDERING CODES

Product markings are detailed in selection guide DTE-120
The ordering code for standard product is

TH 7811 CD Z

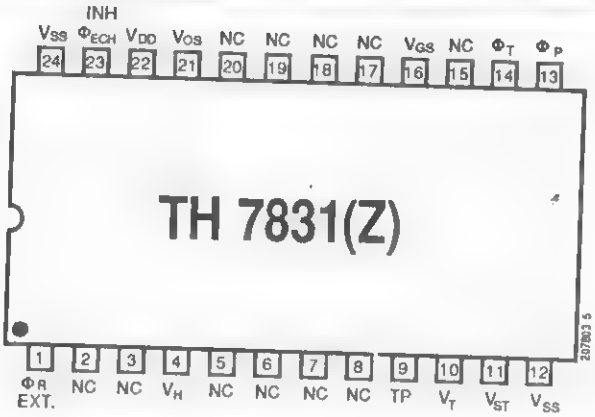
- C : Ceramic substrate
- D : Temperature range : - 25°C to + 70°C (other ranges may be available)
- Z : Special Near Infra Red optimized substrate

THOMSON-CSF
TUBES ELECTRONIQUES

TH 7831(Z)

Linear CCD* Image Sensor

1728 pixels

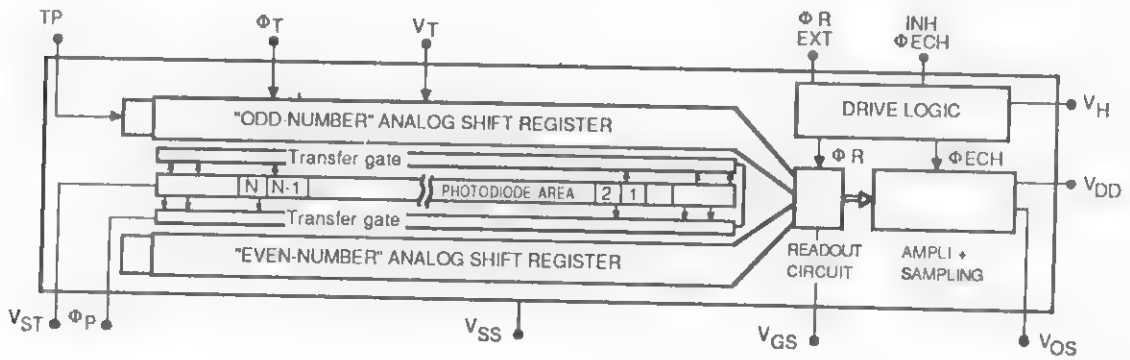


- Pixel size : 13 μm x 39 μm (13 μm pitch)
- Especially high sensitivity, due to the threefold enlarged aperture width
- Simple operation :
  - three drive clocks
  - Internal sample-and-hold with disabling option
  - Dark reference incorporated
- Peak-to-peak output : 2 volts
- High dynamic range and resolution over a wide spectral range : from blue (400 nm) up to Near Infrared (1100 nm), thanks to special semiconductor process
- Low dark signal
- Dynamic range : 6000:1 (typ.)
- 24-pin DIL package

PIN IDENTIFICATION

Pin no.	Symbol	Designation
1	Φ_R EXT	External Reset Clock
4	V_H	Internal Logic Supply Voltage
12-24	V_{SS}	Substrate Voltage (Ground)
9	TP	Test Point
10	V_T	Shift Register DC Bias
11	V_{ST}	Photosensitive Zone DC Bias
13	Φ_P	Transfer Clock
14	Φ_T	Shift Register Transport Clock
16	V_{GS}	Output Gate DC Bias
21	V_{OS}	Video Output Signal
22	V_{DD}	Output Amplifier Drain Supply
23	INH Φ_{ECH}	Internal Sampling Clock Inhibiting Input (DC Bias)
2-3-5-6-7-8-15-17-18-19-20	NC	No Connection (Do not ground)

* Charge Coupled Device



NOTE : To simplify sensor operation a drive board has been developed and may be purchased from Thomson-CSF (ref. TH 7931C). This board provides all the necessary electronics : DC supplies, driving clocks and video ouput buffer.

THOMSON-CSF / DIVISION TUBES ELECTRONIQUES
38 rue Vauthier / B.P. 305 / 92102 Boulogne-Billancourt Cedex / France / Tél. : (1) 46.04.81.75

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TUBES ELECTRONIQUES

ABSOLUTE MAXIMUM RATINGS

Storage temperature ..... - 55 °C to + 150 °C
Operating temperature ..... - 40 °C to + 70 °C
Maximum voltages :
- Pins : 1, 4, 9, 10, 14, 16, 22, 23 ..... - 0.3 V to + 18 V
- Pins : 11, 13 ..... - 0.3 V to + 16 V
- Pins : 12, 24 ..... 0 V

OPERATING CONDITIONS (T = 25 °C)

Table I - DC Characteristics

Parameter	Symbol	Value			Unit
		Min.	Typ.	Max.	
Internal Logic Supply Voltage	V_H	13.5	14	14.5	V
Shift Register and Output Gate DC Bias	V_T, V_{GS}	6	6.4	6.8	V
Photosensitive Zone DC Bias	V_{ST}	5.5	V_T	7	V
Output Amplifier Drain Supply	V_{DD}	13.5	14	14.5	V
Substrate Voltage	V_{SS}	0.0	0.0	-	V
Test Point	TP	-	V_{DD}	-	V

Table II - Drive Clock Characteristics
(See timing diagram - fig.1)

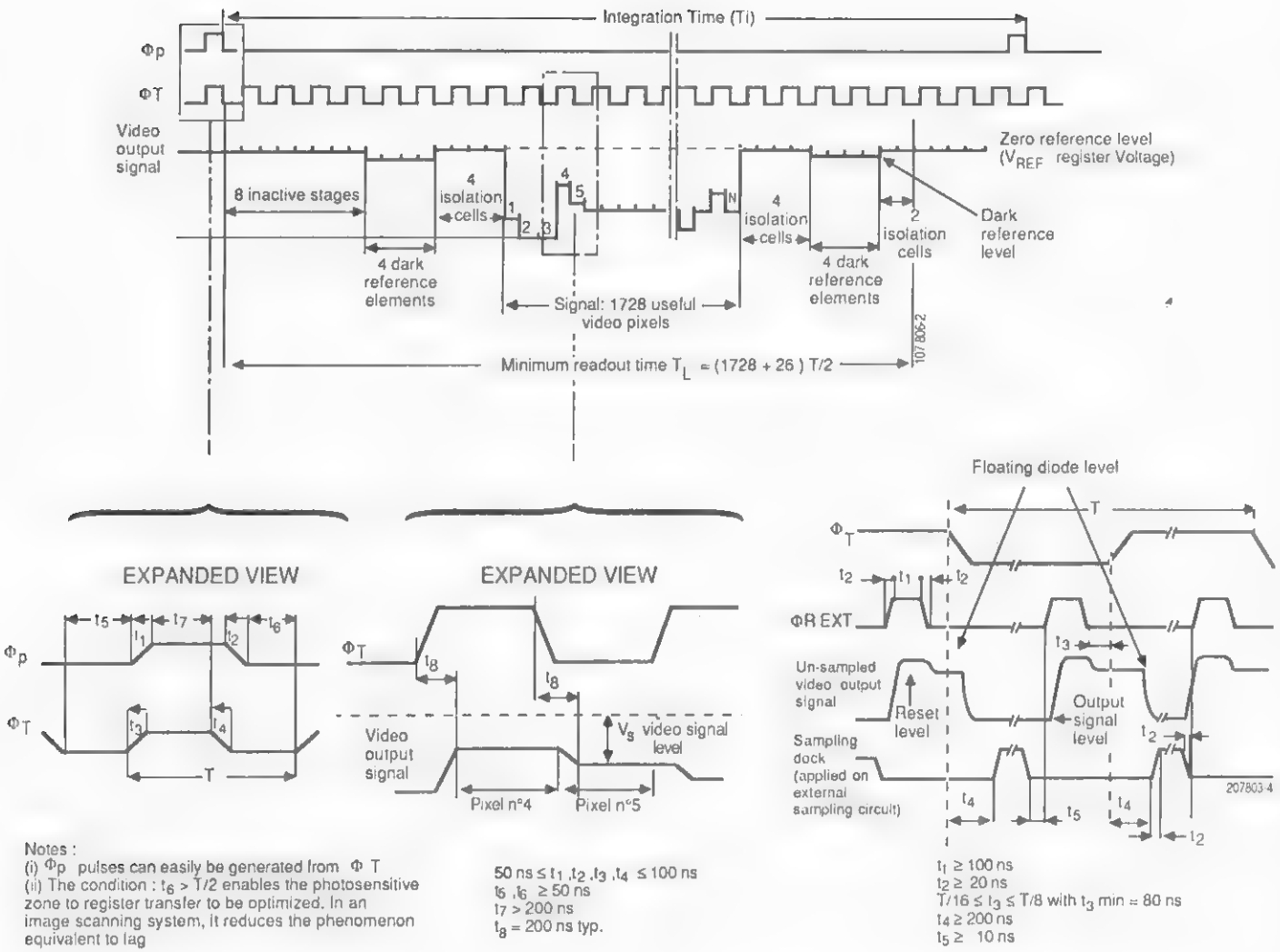
Parameter	Symbol	Logic	Value			Unit
			Min.	Typ.	Max	
Transfer Clock (1)	Φ_P	High	12	12.5	13	V
Register Transport Clock (1)	Φ_T					
External Reset Clock (1)	Φ_{REXT}	Low	0.0	0.4	0.6	V
Register Clock Capacitance	$C\Phi_T$		-	650	850	pF
Transfer Clock Capacitance	$C\Phi_P$		-	150	200	pF

(1) Transients under 0.0 V in the clock pulses will lead to charge injection, causing a localized increase in the dark signal. If such spurious negative transients are present, they can be suppressed by inserting a serial resistor of appropriate value (typically 20 to 100 Ω) in the corresponding driver output.

Table III - Static and Dynamic Electrical Characteristics

Parameter	Symbol	Value			Unit	Remark
		Min.	Typ.	Max.		
DC Ouput Level	V_{REF}	6	8	11	V	(5)
Ouput Impedance	Z_s	-	500	-	Ω	(5)
Single-stage Transfer Efficiency	-	99.992	99.998	-	%	$\bar{V}_{OS}$ = 1V (3)
Max. Data Ouptut Frequency	Fs max.	1.0	2.0	-	MHz	(4) See fig. 2
Input Current on Pins : 9, 10, 11, 13, 14, 16	I_e	-	-	2	µA	Ve = 15 V All other pins : 0V
Input Current on Mode Selection Pins (V_{DD}=VH=15V)	Φ_{REXT} INH Φ_{ECH}	-	-	0.2	mA	Ve = 15 V
Average Current Sink on Φ_T Clock	$I\Phi_T$	-	1.8	-	mA	t_{rise} = 50ns Fs = 2 MHz
Peak Current Sink on Φ_T Clock	$(I\Phi_T)_p$	-	240	-	mA	t_{rise} = 50 ns
Peak Current Sink on Φ_P Clock	$(I\Phi_P)_p$	-	70	-	mA	t_{rise} = 50 ns
Internal Logic Supply Current	I_H	-	3.5	5.0	mA	-
Output Amplifier Supply Current	I_{DD}	-	2.0	5.0	mA	-
Static Power Dissipation	P_D	-	100	150	mW	-

(3) $\bar{V}_{OS}$ = average video output voltage. Measurement excludes first and last pixels.
(4) Fs = 2FΦ_T. The minimum clock frequency is limited by the increase in dark signal.
(5) Shorting the video output to V_{SS} or V_{DD}, even temporarily, can permanently damage the ouput amplifier



Notes :
(i) Φp pulses can easily be generated from Φ T
(ii) The condition : $t_6 > T/2$ enables the photosensitive zone to register transfer to be optimized. In an image scanning system, it reduces the phenomenon equivalent to lag

50 ns ≤ t_1 ,t_2 ,t_3 ,t_4 ≤ 100 ns
t_5 ,t_6 ≥ 50 ns
t_7 > 200 ns
t_8 = 200 ns typ.

t_1 ≥ 100 ns
t_2 ≥ 20 ns
T/16 ≤ t_3 ≤ T/8 with t_3 min = 80 ns
t_4 ≥ 200 ns
t_5 ≥ 10 ns

Figure 1a - Standard operating configuration (all internal clocks used)

Figure 1b - Operating configuration with external reset ($\Phi_{R\,EXT}$) and / or external sample-and-hold

Figure 1 - Timing diagram

VIDEO OUTPUT SAMPLING

The output amplifier incorporates a sample-and-hold circuit controlled by Φ_{ECH} sampling pulses at F_S data frequency. The resulting V_{OS} output signal is in the form of a staircase waveform, as shown on figure 1.

UN-SAMPLED OUTPUT OPTION *

The INHΦ_{ECH} control input is accessible to inhibit the internal sample-and-hold function. An external sample-and-hold may then be substituted for the internal circuit.

Table IV - Sampling Mode Selection

Mode	INHΦ_{ECH} (pin 23) connection
Normal : Internal Sampling	NC or V_{SS}
Unsampled Output Option	V_{DD}

NC = Not Connected

* Available on specific request only - devices are individually tested for this option. Please consult Thomson-CSF.

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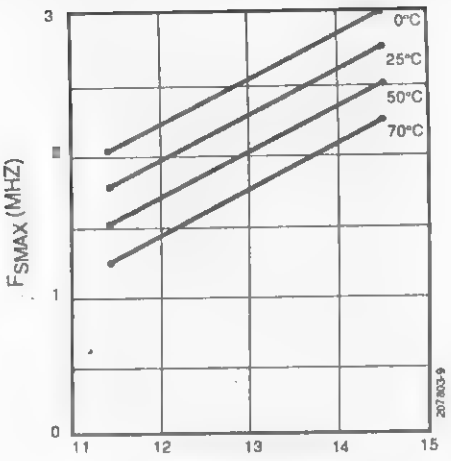
ELECTROOPTICAL PERFORMANCE

General measurement conditions :
T_p = 25 °C; Ti = 10 ms; Fs = 1 MHz;
Light source : tungsten filament lamp (2854 K) + IR cut-off filter (Schott KG1 + BG38).
Typical operating conditions; normal mode (internal sampling)
(See table IV).
First and last pixels, as well as dummy elements are excluded from measurement.

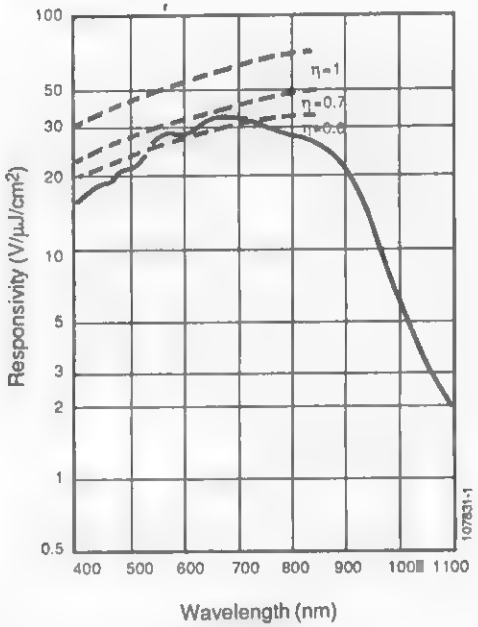
Table V - Electrooptical Performance

Parameter	Symbol	Value			Unit	Remark
		Min.	Typ.	Max.		
Saturation Output Voltage	V_{SAT}	1.3	2.0	3.5	V	(6) (8)
Saturation Exposure	E_{SAT}	-	0.11	-	µJ/cm²	(7)
Responsivity	R	12	17	-	V/µJ/cm²	See Fig. 3
Temporal Noise in Darkness		-	350	-	µV(rms)	-
Dynamic Range (relative to rms noise)	DR	3000	6000	-	-	-
Average Dark Signal	V_{DS}	-	0.5	8	mV	(6)
Dark Signal Non-Uniformity	DSNU	-	0.5	8	mV	-
Amplitude of Signal Defects in Darkness	-	-	-	80	mV	-
Photo Response Non-Uniformity : - Single Defects Excluded - Peak-to-peak	PRNU	- -	± 5 -	- ± 15	% $\bar{V}_{OS}$	$\bar{V}_{OS}$=1volt
Contrast Transfer Function at FN (38 lp/mm)	CTF	-	60	-	%	See Fig. 4



Power Supply voltage (V)
$V_{DO}=V_H$

Figure 2 - Max. data output rate vs. supply voltage (Typical curves)



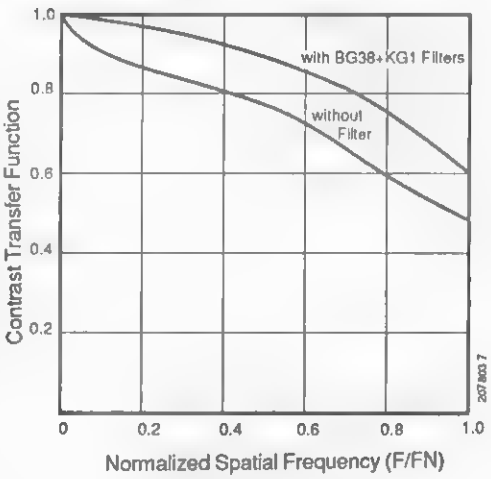
Wavelength (nm)

Figure 3 - Typical spectral response

ELECTROOPTICAL PERFORMANCE WITHOUT INFRARED CUT-OFF FILTERING

The TH 7831(Z)'s special semiconductor process enables it to exploit the silicon's high near infrared sensitivity while maintaining good imaging performance in terms of response uniformity and resolution. Typical changes in performance with and without IR filtering are summarized below.

	With IR cut-off Filter	No IR cut-off Filter
Average video signal due to a given scene illumination	V_{OS}	V_{OS} x 6
PRNU (Single Defects Excluded)	± 4 %	± 5 %
CTF at Nyquist frequency	60 %	40 %

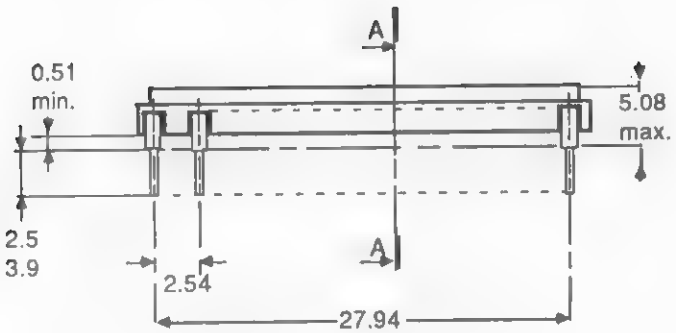


Normalized Spatial Frequency (F/FN)

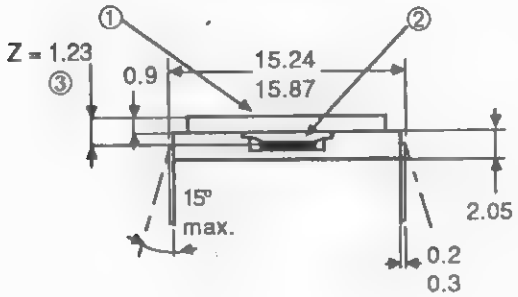
Figure 4 - CTF Typical curves (2854K source)

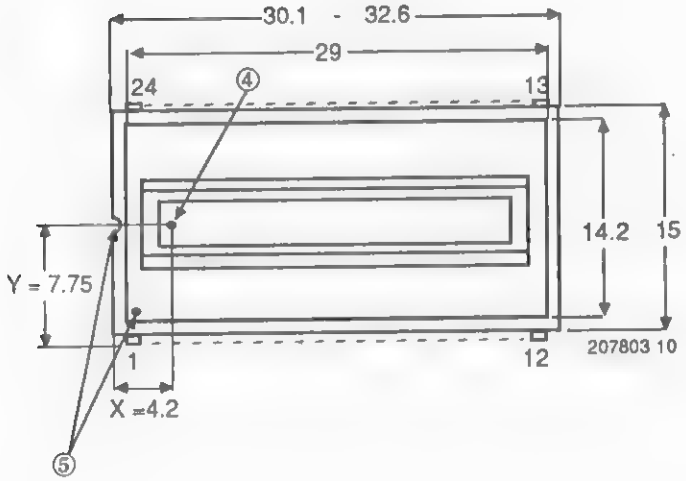
(6) Value measured with respect to signal zero reference level.
(7) For T_I = 10 ms, the corresponding illumination is 11 µW/cm²
(8) Conversion factor i.e. video output signal / readout charge is typically 1.4 µV/e⁻

OUTLINE DRAWING

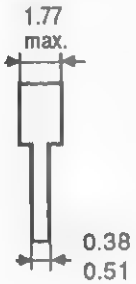


AA CROSS-SECTION





PIN DETAIL



① Window
② Photosensitive area
③ Optical distance between external face of window and photosensitive area
④ Pixel n°1 (first useful pixel in the video line defined by its X,Y,Z coordinates)
⑤ Index (notch or dot)

Dimensions in mm

ORDERING CODES

Product markings are detailed in selection guide DTE-120
The ordering code for standard product is

TH 7831 CD Z

- C : Ceramic substrate
- D : Temperature range : - 25°C to + 70°C (other ranges may be available)
- Z : Special Near Infra Red optimized substrate

THOMSON-CSF
ELECTRON TUBES

TH 7932

APRIL 88

DATA SHEET ADDITIVE

DRIVE MODULE
FOR TH 7805A(Z) LINEAR CCD IMAGE SENSOR

In order to improve operation at 10MHz on 50 Ω impedance, TH 7932 board is modified with respect to the data sheet (TEV 3675).

Modifications are following :

- suppression of C41, C42, C46, C47 capacitors,

- video output A : Pin 17
  GND video output A : Pin 18

- video output B : Pin 15
  GND video output B : Pin 16

Pin 11 and Pin 13 are no more used as video output.

THOMSON-CSF
TUBES ELECTRONIQUES

TH 7932
(ex TH X1074)

Drive Module
for TH 7805A(Z) Linear CCD* Image Sensor

- **Provides both (odd and even) video signals****
- **Inputs :**
  — two external dc voltages
  — two external drive clocks
- **Five outputs :**
  — 50 Ω matched video signal with or without filtering
  — line synchronization signal
  — pixel synchronization signal
  — envelope signal for first 4 dark ref. pixels
  — external sample and hold pulses
- **Two adjustments possible (internally on board or by external signals)**
  — integration time
  — video signal readout time
- **Eurocard format PCB with DIN41612 connector**

The TH 7932 (ex TH X1074) drive module is designed to simplify the use of the TH 7805A(Z) linear CCD image sensor.

The board requires only two external dc voltages (+ 5 V and + 18 V) and provides all the necessary drive signals and dc biasing. In conjunction with the image sensor used, it delivers a low impedance video output signal, as well as the " line " and " pixel " synchronization signals.

The integration time is adjustable to control the exposure and thus adapt to scene illumination. The signal readout time can also be adjusted as a function of the integration time and the operating mode chosen.

Integration and readout times can be adjusted on the board or by external drive clocks.

* Charge-Coupled Device.

** Does not include optics or power supply.

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DESCRIPTION

The TH 7932 comes as a 100 mm × 160 mm fitted printed circuit board. The schematic diagram is given in Figure 6.

An oscillator Z4 (74S124) or an external clock with TTL output controls the readout output transfer phase Φ_T as well as the synchronization of the internal phase Φ_P with Φ_T. The frequency of the oscillator is four times that of the transfer clock Φ_T and twice the readout frequency of the video line output. The frequency division is ensured by bistables Z2 and Z3 (74HC74).

The integration time is defined by the rising edges from monostable Z1 (74HC123) or an external TTL signal.

POWER SUPPLIES

Only two external power supplies are required :
- Pin no. 31 : connects to + 5 V ± 5 % / 250 mA.
- Pin no. 3 : connects to + 18 V $^{+\ 1}_{-\ 0.5}$ V / 150 mA.
- Pin no. 32 : connects to the logic ground.
- Pin no. 1 : connects to the analog ground.

INPUT SIGNALS

They comprise two external clocks :
- Pin no. 30 : integration time command clock.
- Coaxial micro-connector : readout clock.

OUTPUT SIGNALS

The output signals are provided on :

- Pin no. 13 : unfiltered video output (A channel)
- Pin no. 11 : unfiltered video output (B channel)
- Pin no. 17 : filtered video output (A channel)
- Pin no. 15 : filtered video output (B channel)
- Pin no. 28 : line sync. signal
- Pin no. 26 : pixel sync. signal

} TTL logic (see figure 2)

- Pin no. 8 : envelope signal of first 4 dark reference pixels in the line.

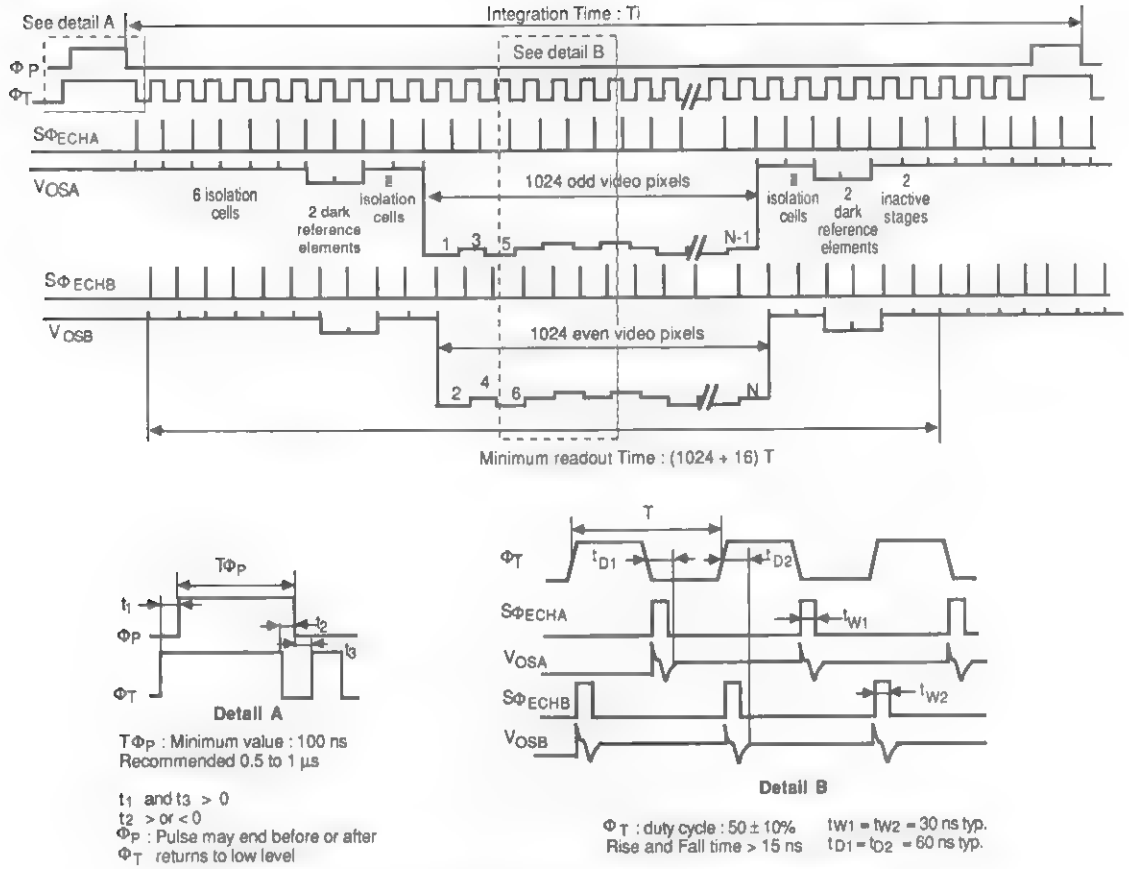

Figure 1 - Timing diagram of linear CCD drive signals

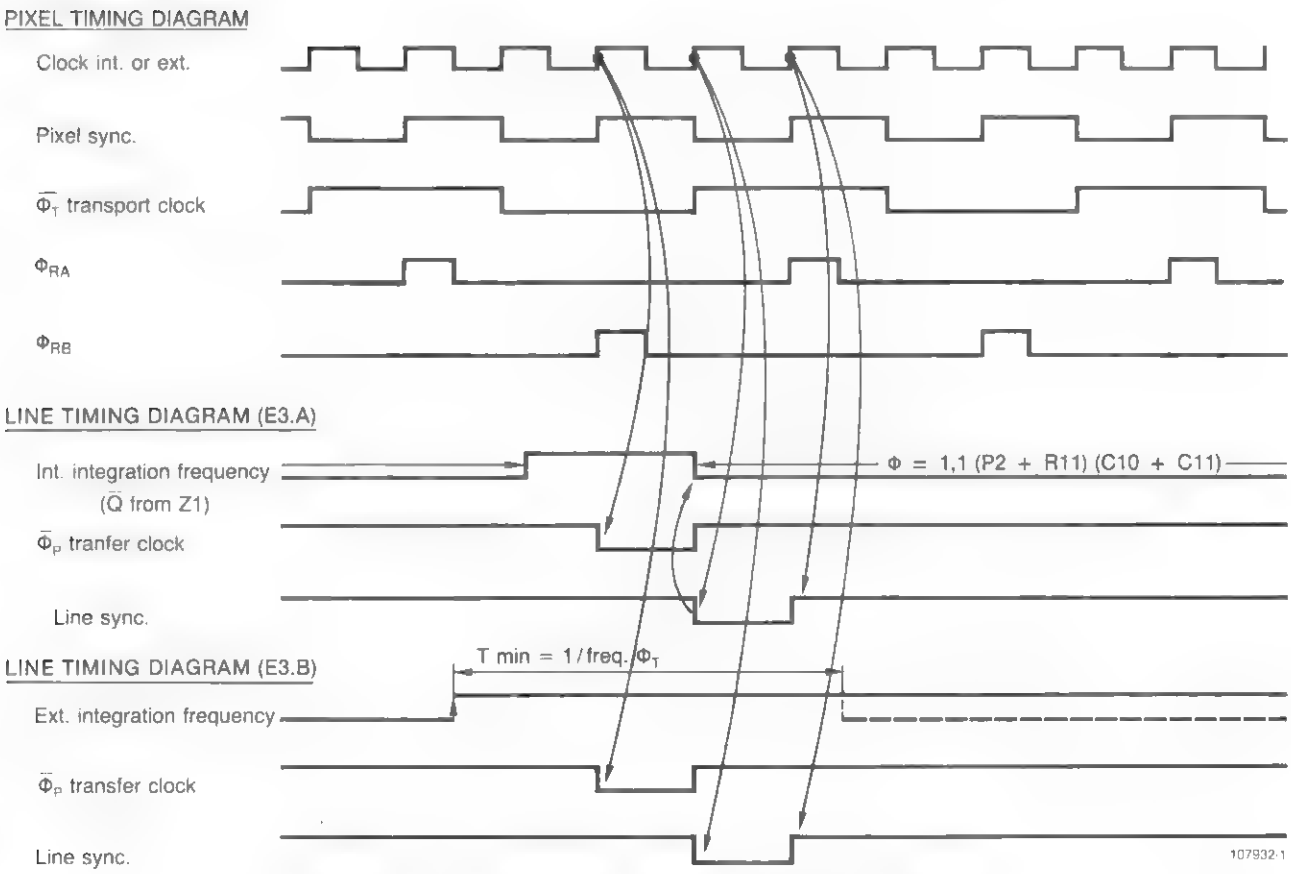

Figure 2 - Timing diagram of logic circuit command signals

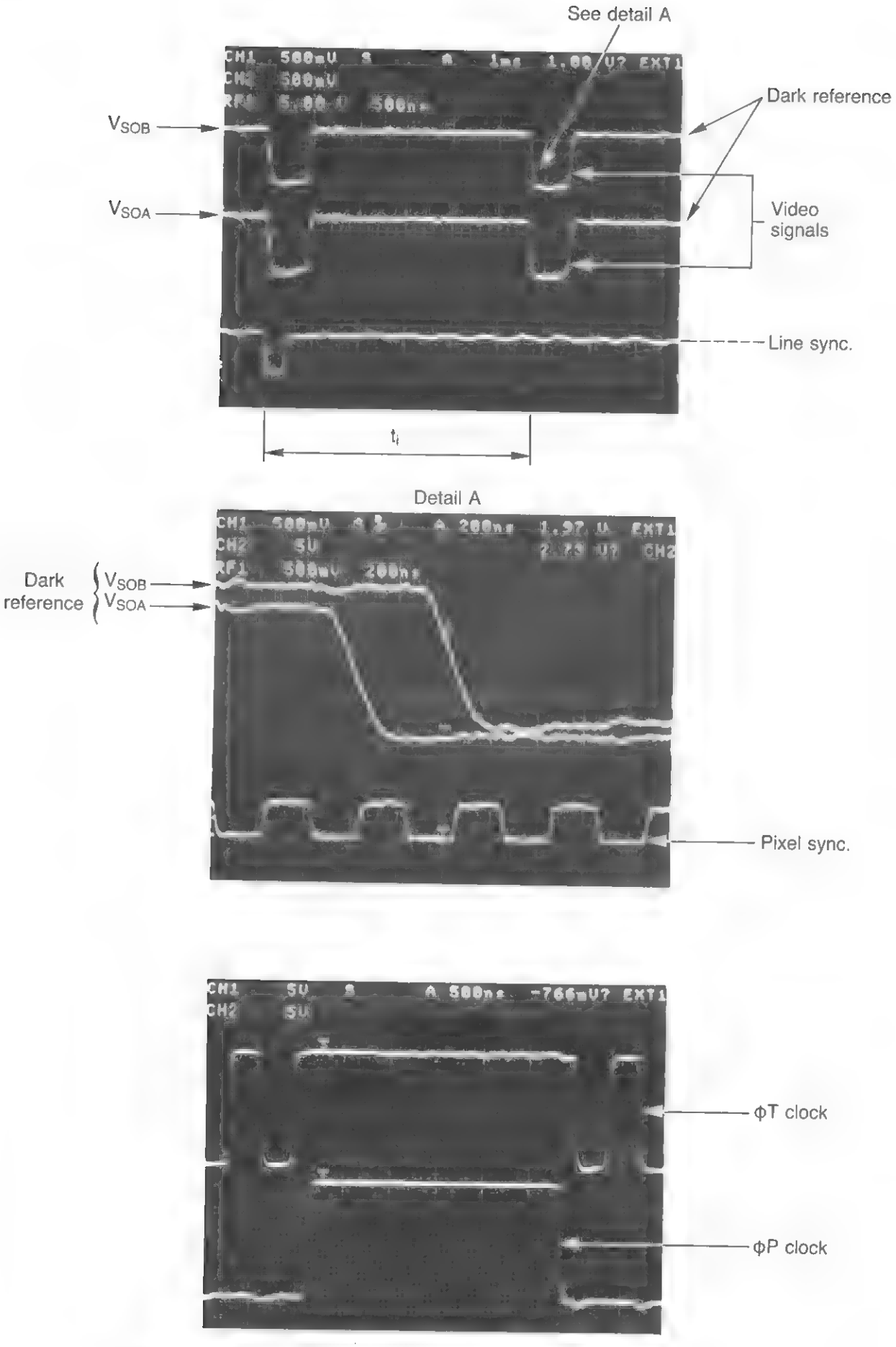

Figure 3 - Video and sync. output signal displayed on digital oscilloscope

ADJUSTMENTS

Integration Time

For nominal value of $C_{10} + C_{11} = 570$ nF :
The integration time (t_i) is adjustable from 6 ms to 60 ms by potentiometer P2.

This adjustment range can be altered by replacing capacitor $C_{10} + C_{11}$ with another capacitor C_x, the new integration times being given by the formula :

$$t_i = 1.1\ (R_{11} + P2)\ C_x$$

where : t_i is in ms
P2 in kΩ ; $R_{11} = 4.7$ kΩ
C_x is in µF.

Readout Time

For nominal $C_{14} = 4.7$ pF :
The readout frequency (f_L) is adjustable between 10 MHz and 20 MHz by P1.

The readout time (t_L) in ms is the number of CCD shift register stages divided by the readout frequency in kHz.

TH 7805A(Z)

(1040 stages)

t_L min.	0.05 ms
t_L max.	0.1 ms

The above readout times (min. and max.) may be modified by replacing capacitor C_{14} by a capacitor C_y, the new readout times being given by the formula :

TH 7805A(Z)

$$t_L \text{ max.} = \frac{1040 \times C_y}{49.000} \cdot 10^{-3}$$

$$t_L \text{ min.} = \frac{1040 \times C_y}{98.000} \cdot 10^{-3}$$

C_y in pF ; t_L in ms.

Remark : If the original values for $C_{10} + C_{11}$ and C_{14} have been changed, ensure that the readout time always remains shorter than the integration time.

CONFIGURATIONS

Several operating configurations are possible (see tables 2 & 3 and figure 5).

NB : The TH 7932 is delivered with the following jumper configuration :

— E3A	integration time controlled by the board.
— E1A and E2A	clock generated by the board.
— E5A and E7A	use of internal reset clock.
— E4B	internal sampling.
— E6A and E8A	sampled video output.

TYPICAL BIAS VALUES

The TH 7932 delivers all the necessary dc levels : V_{DD} = 15 V ; $V_T = V_{GS}$ = 6.15 V. These voltages ensure optimum operation irrespective of the sensor used and no adjustment of these values is necessary.

Table 1 - Pin-out of TH 7932 connector

Pin no.	Designation
31	+ 5 V
3	+ 18 V
32	Logic ground
1	Analog ground
30	Integration time command input (or ext. integration frequency)
13-11	Unfiltered video output (channel A - B)
17-15	Filtered video output (channel A - B)
26	Pixel sync. output
28	Line sync. output
8	Clamp pulse output

Table 2 - TH 7932 operating modes

Function modified	Configuration		Jumper
	Jumper Jumper in position A	Jumper in position B	
Integration frequency	Internal	External	E3
Clock	Internal	External	E1 and E2
Φ reset	Internal	External	E5 and E7
Internal sampling inhibition	Normal mode internally sampled	Internal sampling clock disabled	E4
Video output sampling	Sampled	Unsampled	E6 and E8

Table 3 - Jumper selections for different operating modes

Operating mode	E3	E1 E2	E5 E7	E4	E6 E8
All internal	A or B	A or B	A	A	A
Internal sampling and external ΦR	A or B	A or B	B	A	A
Unsampled video output internal ΦR	A or B	A or B	A	B	B
Unsampled video output external ΦR	A or B	A or B	B	B	B

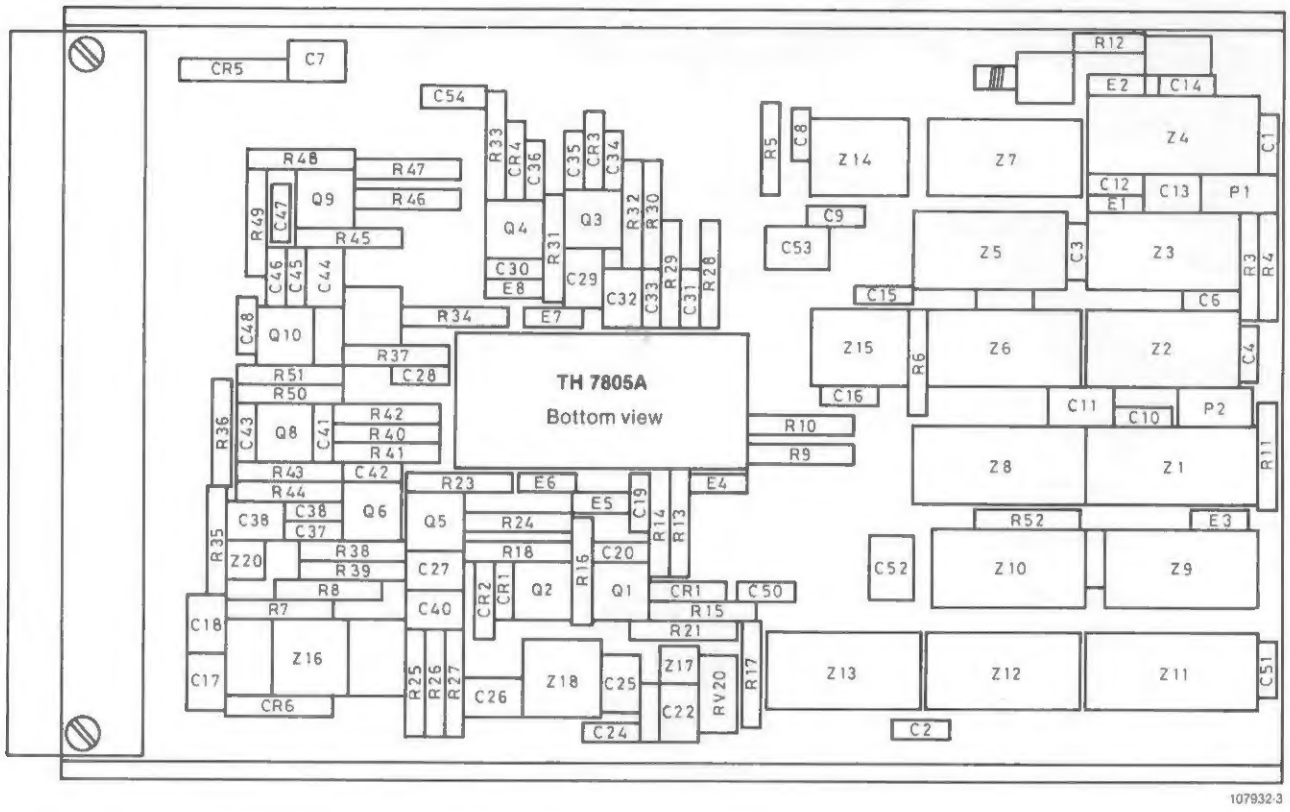

Figure 4 - Fitted printed circuit board

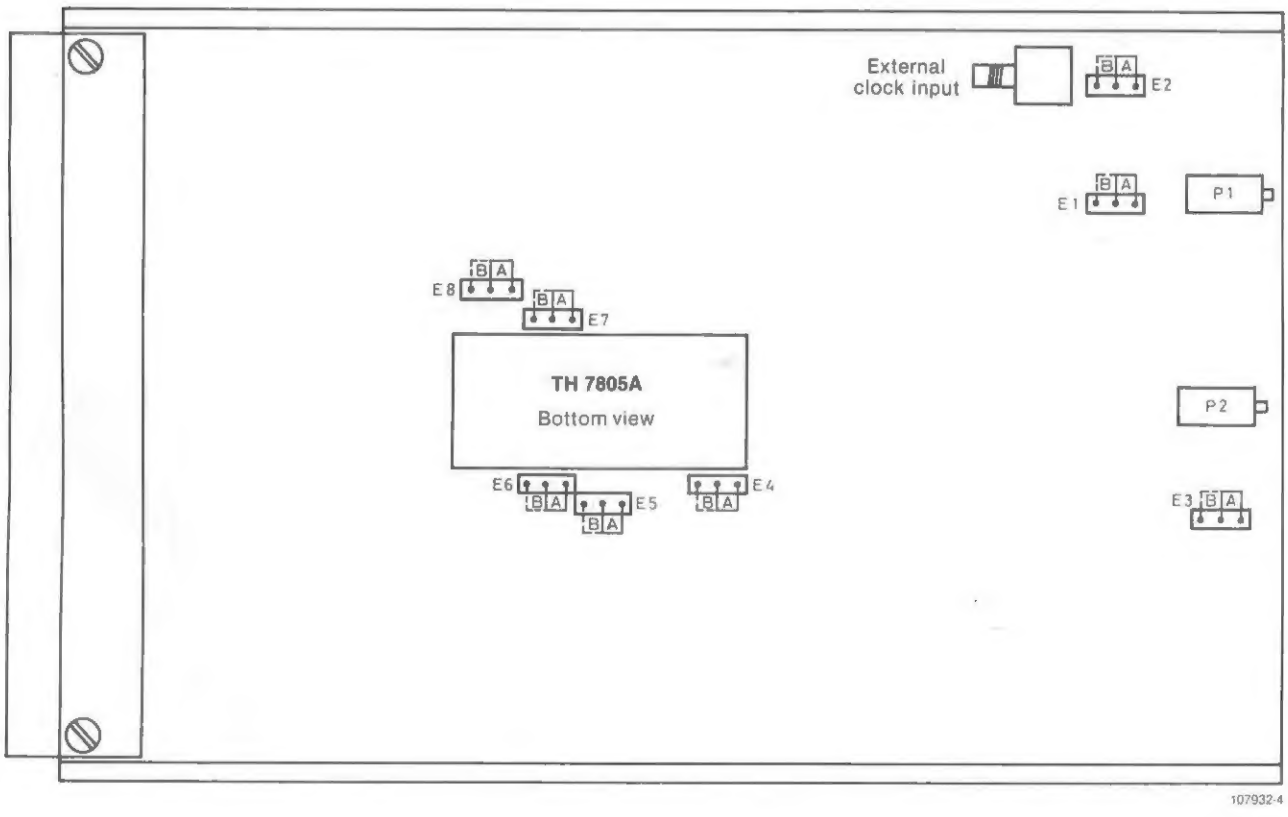

Figure 5 - Jumper and variable resistor locations

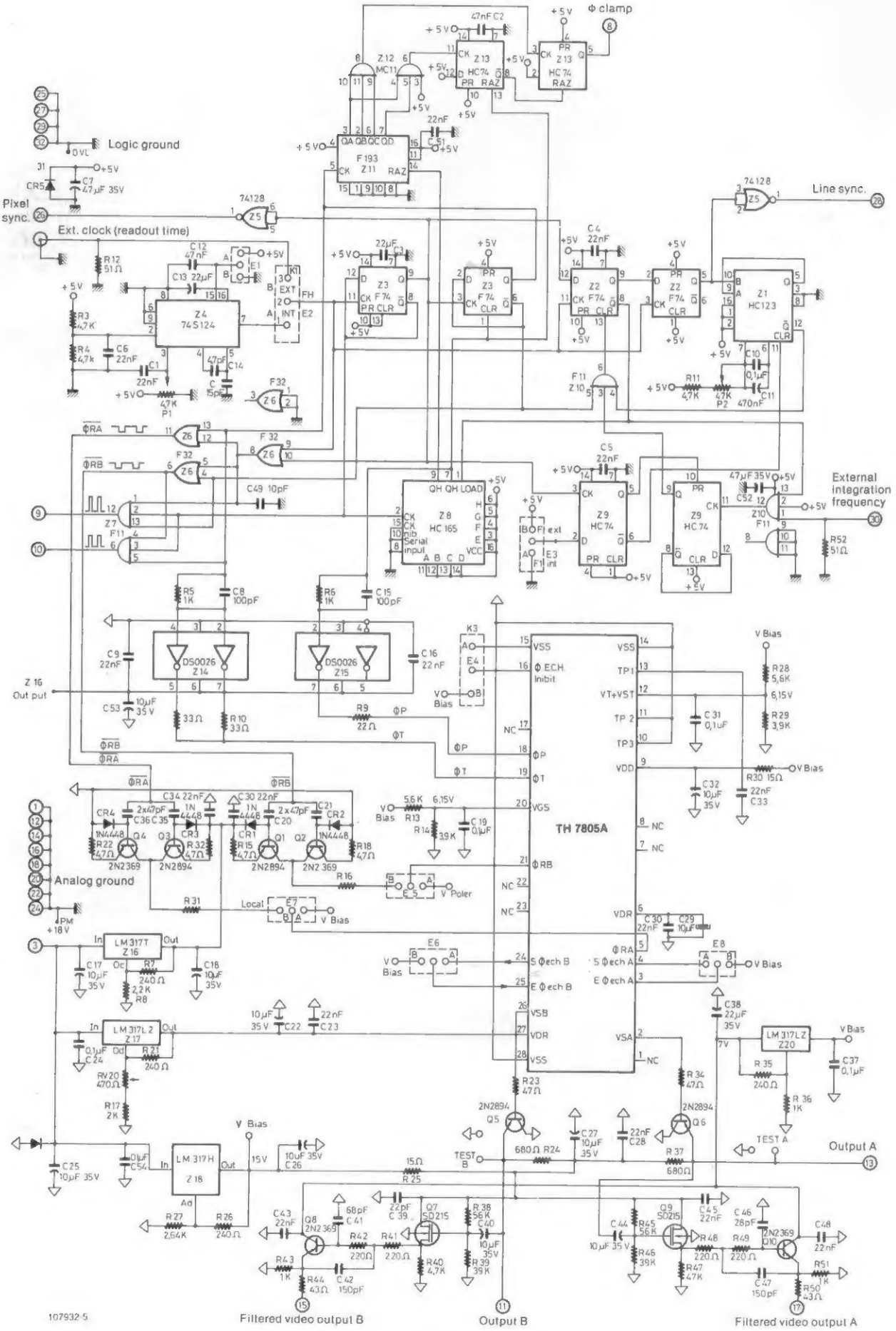

Figure 6 - Circuit diagram